A CRITICAL EVALUATION OF THE LOWER-MIDDLE PALAEOLITHIC ARCHAEOLOGICAL RECORD OF THE CHALK UPLANDS OF NORTHWEST EUROPE

The Chilterns, Pegsdon, Bedfordshire *(photograph L. Blundell)*

Lesley Blundell

UCL

Thesis submitted for the degree of PhD

September 2019

I, Lesley Blundell, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

Signed:

Abstract

Our understanding of early human behaviour has always been and continues to be predicated on an archaeological record unevenly distributed in space and time. More than 80% of British Lower-Middle Palaeolithic findspots were discovered during the late 19th/early 20th centuries, the majority from lowland fluvial contexts. Within the British planning process and some academic research, the resultant findspot distributions are taken at face value, with insufficient consideration of possible bias resulting from variables operating on their creation. This leads to areas of landscape outside the river valleys being considered to have only limited archaeological potential. This thesis was conceived as an attempt to analyse the findspot data of the Lower-Middle Palaeolithic record of the Chalk uplands of southeast Britain and northern France within a framework complex enough to allow bias in the formation of findspot distribution patterns and artefact preservation/discovery opportunities to be identified and scrutinised more closely.

Taking a dynamic, landscape = record approach, this research explores the potential influence of geomorphology, 19th/early 20th century industrialisation and antiquarian collecting on the creation of the Lower-Middle Palaeolithic record through the opportunities created for artefact preservation and release. It also explores the influence of differences between British and French Government archaeological policies and strategies, visualising the impact of each variable in turn on the creation of the findspot distribution patterns visible in that record. Based on the results of these visualisations, the thesis concludes that geomorphology has been the first and most influential variable, providing a more robust first-order explanation for distribution patterns than early human habitat preference alone. Late 19th/early 20th century industrialisation played the next most substantial role, its exposure of Pleistocene deposits creating opportunities for the antiquarian collectors whose activities ultimately created the findspot distribution patterns on which interpretations of early human behaviour have traditionally been based.

Impact Statement

This thesis draws on Palaeolithic archaeology, Quaternary science and geomorphology to undertake an interdisciplinary enquiry into how our archaeological record was created. It examines the complex relationship between the record of human behaviour in the deep past, recent landscape use, the history of archaeological research and the distribution of surviving Pleistocene deposits. Focusing on the detailed Lower-Middle Palaeolithic record of the Chalk landscapes of southeast Britain and northern France, it proposes a new framework for looking at the archaeological data in relation to geomorphology that is directly transferable to other lowland landscapes dominated by soft-rock geology. The use of archaeological distribution patterns to identify early human landscape preference and behaviour is a key area of research within Lower-Middle Palaeolithic archaeology. This thesis makes a substantial contribution to that research by identifying the impact of external variables on the creation of those distribution patterns, thus enabling fuller and more rounded behavioural interpretations. In addition, the ability to identify the location of pockets of Pleistocene deposits without prior excavation by means of the electrical geophysical survey method tested during the Bellingdon case study potentially facilitates prospection for *in situ* Lower-Middle Palaeolithic archaeology at substantially reduced cost.

Outside academia, this thesis has the potential to make a positive contribution to the local authority planning process and to conservation of the national heritage asset at a time when financial pressures have resulted in a substantial fall in the number of local authority historic environment advisory staff. Palaeolithic archaeology requires a specialised approach to fieldwork and the interpretation of the record at site and landscape scale and understanding the processes of preservation and release through which the archaeological record was formed is crucial for making informed planning decisions. By demonstrating that apparent distribution patterns in the archaeological record do not necessarily represent the true original and temporally dynamic distribution of past human behaviour through deep time, my research could inform the desk-based assessments and unsuitable (for the Palaeolithic) survey methods used during the planning process by non-Palaeolithic specialists to assess the likelihood of archaeological discovery and/or need for archaeological intervention.

Testing the use of electrical resistance tomography and electromagnetic survey to identify surviving Pleistocene deposits during the Bellingdon case study could potentially provide a more appropriate survey method.

This thesis offers the basis for dissemination of its conclusions in journals and conference papers in the fields of archaeology, Quaternary science, local authority planning and heritage management.

Acknowledgements

This thesis could not have been completed without the generous assistance of many people, to whom my grateful thanks are due.

First and foremost I thank my supervisors, Matt Pope, Andy Garrard and the late John Catt, my geomorphology supervisor, for all their support, guidance and encouragement. John's generosity and patience in sharing his expertise and knowledge of Clay-with-flints with a student who at first knew nothing about geomorphology was limitless and I deeply regret that he did not live to see me finish this thesis. I hope I have done him justice. Andy's unfailing support, encouragement and interest in my progress throughout what has been a longer than expected PhD journey has kept me grounded and bolstered my determination to continue. It is very much appreciated. And finally, I thank Matt, who first conceived of a unified landscape approach to the Palaeolithic and suggested a potential link between Clay-with-flints survival and findspot density. Throughout, Matt has encouraged, challenged and stimulated me and pushed me to think in new and different ways. His expertise and boundless enthusiasm for the subject have kept me going and made the whole process exciting, for which I cannot thank him enough.

Members of various departments of UCL provided help in a number of ways. From the Institute of Archaeology, Andy Bevan and Marc Vander Linden offered helpful advice on the best way to present spatial archaeological data and Peter Schauer repeatedly solved my practical problems with remote access to ArcGIS software. Nick Mann of the Geography Department Map Room offered me access to hard-copy French geology maps and supplied me with scanned copies of the most relevant ones. Robert Tomaszewski of the Geology Department Library tracked down and purchased a multilingual dictionary of geological terms at my request. I could never have got to grips with the French geological terminology without it!

Staff from a range of institutions responded willingly to my numerous enquiries and/or welcomed me to their offices and I thank them all. The following Historic Environment Officers provided me with hospitality when I visited and provided me with access to the relevant hard-copy full English Rivers or Southern Rivers Palaeolithic Project report, to HER records not

available online and to supporting grey literature. They are Stephen Coleman (Bedfordshire), Laura Hampden (Surrey), Susan Lisk (Oxfordshire) and Isobel Thompson (Hertfordshire), who also supplied me with a download of the Palaeolithic data from the county HER. Ben Croxford of Kent HER supplied me with electronic copies of the full reports 2 and 3 of the Southern Rivers Palaeolithic Project, obviating the need for me to travel to Kent or Sussex HERs to consult them.

Several Portable Antiquities Scheme Finds Liaison officers resolved my queries and provided me with access to records still ‘on review’ or ‘quarantined’ to enable me to check their relevance or otherwise to my research. They are Rosalind Tyrell (Buckinghamshire), Jennifer Jackson (Kent), Katie Hinds (Hants), Ciorstaidh Hayward Trevathan (Dorset) and Kate Sumnall, Finds Liaison Officer and Community Archaeologist at the Museum of London. Samantha Harris, Collections Manager at Maidstone Museum sent me scanned copies of the 6” OS maps on which Benjamin Harrison marked his finds and which are stored at the museum.

I am grateful also to Heydon Bailey, Geology Advisor to the Chiltern Society, a specialist in Chalk field studies who kindly put me in touch with Ursula Lawrence, an engineering geologist; to Ursula for supplying me with a copy of her PhD thesis on the Clay-with-flints of the areas around the Thames Basin and discussing the stability of the deposits with me; to Rob Hosfield of Reading University for loaning me a hard copy of his thesis on the Palaeolithic of the Hampshire Basin; and to Martin Bates of the University of Wales Trinity St David’s for the loan of his hard copy geology maps of the Somme valley region of France and for introducing me to the mysteries of Electro-magnetic and Electro-resistivity Tomography surveying.

Thanks are owed to a number of French colleagues, who coped with my poor French and gave generously of their knowledge. They are David Hérisson of INRAP and Anne-Lise Révon of the University of Rennes, who advised me on how to approach the French archaeological data; Émilie Goval of the Service Régional de l’Archéologie, Amiens and Mickaël Cortiller and Valerie Burban-Col of the DRAC Amiens document centre , who uncomplaining retrieved dozens of archaeological reports for me. All three made me very welcome during my stay in their city.

Last, but not least, I thank all my family and friends for their patience and understanding during years of neglect while I focused on this PhD to the exclusion of all else, yet who were there whenever I needed them or had time to spare. In particular I thank my sister Avril who, while never really understanding why I wanted to do a PhD, accepted it as something I needed to do and has waited uncomplainingly until it was over. Special thanks also to my friend Pat, for all her support, for making me laugh and keeping me sane. And to Ann, Martina and Rosie for their unwavering conviction that I could do this and their encouraging texts, cards and postcards whenever I wobbled. I particularly thank Rosie for the loan of her ‘miracles’ bracelet – it worked!

This PhD is dedicated to Mum and Dad, who would have been so proud, but probably not surprised that this is where I ended up!

CONTENTS.

Signed declaration…… .3
Abstract…….5
Impact statement…….6
Acknowledgments ……..8
Dedication……11
List of contents……12
List of figures……18
List of maps……..21
List of tables……22

Chapter One. Introduction

i) Overview……24
ii) Research aims and questions……29
iii) Core and control study areas……30
iv) Why study the Chalk uplands……...33
v) Thesis structure……36
vi) Summary……..39

Chapter Two. Early interpretations of the northwest European Palaeolithic archaeological record

i) Introduction…….… 41
ii) The heroic age……45
- *Catastrophism*……45
- *Uniformitarianism*……..……48

iii) The age of the collectors……..53
- *Unilinear cultural evolution*…….……...53
- *The eolith debate*……60

iv) The age of experimentation…….68
- *Parallel cultural evolution*……...68

vi) Summary……77

Chapter Three. Current interpretations of early human landscape use and behaviour

i) Introduction……..79
ii) Social organisation…….81
- *Local hominid networks and social landscapes*……81
- *Neanderthal local operational areas*……...86

iii) Population modelling…….89
- *Deserted Britain model*……..91
iv) Colonisation patterns…….96
v) Landscape use……99
- *The riparian preference model*……..99
- *The nutritional niche model*……..102
- *The routed foraging model*……104
- *Persistent places*……105
- *The static and mobile resource model*……108
vi) Patterns of upland and lowland living……109
vii) Lower-Middle Palaeolithic archaeology and deposits mapped as Clay-with-flint……..114
viii) Summary……117

Chapter Four. Materials and methods

i) Introduction……121
ii) Development of a geomorphological method of landscape change..123
iii) Development of a GIS-based approach to testing the implications of geomorphological factors for the archaeological record……124
iv) Creation of site lists – sources, methodological conventions and search terms used……125
- *British site lists*……125
- *Issues encountered*……129
- *French site lists*……...132
v) Creation of geological findspot distribution maps……135
vi) Analysis of the findspot distribution maps……146
- *Issues encountered*……148
vi) Analysis of the discovery circumstances of each site……..156
vii) Summary……156

Chapter Five. The geomorphology of the Chalk uplands of Southeast Britain and northern France: implications for the archaeological record

i) Introduction……..158
ii) Geological history of southeast Britain and northern France…….163
a) Bedrock geology……164
- *Formation and nature of Chalk*……..164

- *Flint*……165

b) Drift (Superficial) deposits……166

- *Clay-with-flints*……167
- *Loess*……172

iii) Landscape evolution during the Quaternary……174

a) Formation of escarpments and secondary escarpments……175

b) Formation and development of the drainage network……176

c) River terrace formation……181

- *Models of river terrace formation*……182
- *Uniclinal shifting*……187
- *Uplift*……189

d) Impact of fluctuating sea-levels……193

- *Breaching of the Weald-Artois Chalk ridge and subsequent insularity*……194

iv) Periglaciation……196

- *Permafrost*……196
- *Solutional lowering and erosion of the interfluves*……196
- *Doline formation*……198
- *Solifluction*……199
- *Formation and development of the dry valley networks*……202

v) A model of geomorphological change……208

Chapter Six. The impact of late 19th/early 20th century industrialisation on Lower-Middle Palaeolithic artefact collection opportunities.

i) Introduction……210

ii) Aggregates extraction……212

- *North Downs*……216
- *South Downs*……219
- *Chilterns*……220

iii) Construction of the railway network……222

- *North and South Downs*……223
- *Chilterns*……224
- *Greater London*……226

iv) Urbanisation……228

v) Summary……232

Chapter Seven. Antiquarian collectors and the archaeological record of the Chalk uplands

i) Introduction……239

ii) The North Downs……..241

- *Benjamin Harrison*……..241
- *de Barri Crawshay*……..247
- *F.C.J. Spurrell*…….248
- *James Cross*……250
- *Alexander James Montgomerie Bell*……251
- *Henry Stopes*……...252

iii) The Chilterns……..255

- *Worthington George Smith*……...255
- *Llewellyn Treacher*…….259
- *G.W. Smith*……..261

iv) The South Downs……..261

v) Northern France……264

- *Victor Commont*……264
- *Salomon*…….265
- *E. Vignard*……..265

vi) Summary……266

Chapter Eight. Differences between English and French national heritage management policies and strategies.

i) Introduction……269

ii) England……269

- *Legislative background and administrative arrangements*…269
- *Archaeological resources at the local and national level*…..274
- *Major infrastructure developments*……276
- *Implications*……..…..278

iii) France……279

- *Legislative background and administrative arrangements*…279
- *Archaeological resources at the local and national level*…..281
- *Major infrastructure developments*……...283
- *Implications*……...285

iv) Discussion……286

Chapter Nine.

The whole landscape matters: identifying the bias in the Lower - Middle Palaeolithic archaeological record of the Chalklands

i) Introduction……289

ii) Visualising the relationship between geomorphology and findspot distribution……291

- *% Clay-with-flints survival*……...291
- *Findspots on the edges of Clay-with-flints*……...301
- *Head deposits*……...303

iii) Visualising the relationship between late 19th/early 20th century industrialisation processes and findspot distribution……..311

- *Gravel and brickearth extraction*……311
- *Urbanisation*……..319
- *Railways*……321

iv) Visualising the relationship between the scale of antiquarian collecting activities and findspot distribution…….323

- *The Chilterns*……...324
- *The North Downs*……326

v) Visualising the relationship between British and French policy and research strategies and the shape of the Lower-Middle Palaeolithic archaeological record……341

- *Differences in the nature and amount of archaeological fieldwork*……....342
- *Differences between the number of finds made on the surface and/or by chance*……...344
- *Differences in the number of total Chalklands Lower-Middle Palaeolithic dataset entries attributed to aggregates/brickearth extraction* ……...344
- *Differences in the number of total dataset entries attributed to infrastructure and urbanisation processes*……346

vi) Summary……..347

Chapter Ten. Discussion

i) Introduction…….353

ii) A critical evaluation of the Lower-Middle Palaeolithic archaeological record of the Chalk uplands: a review of the evidence…….355

- *Geomorphology*……...355
- *Late 19th/early 20th century industrialisation*…….362
- *Antiquarian collecting*……..366
- *Differences in Government policy and research strategies*……..369

iii) The palaeoenvironmental context of the Chalk uplands…...……...370

iv) An uplands led perspective on Lower and Middle Palaeolithic landscape use ……375

v) Suggestions for future work …… 381

vi) Conclusion……...384

Appendix 1 Testing the potential of electrical geophysical survey to locate solution hollows containing primary context Middle Pleistocene deposits: the Bellingdon case study

i) Introduction……389

ii) Electromagnetic (EM) survey…….392

iii) Electro-resistivity Tomography (ERT)…….395

iv) Ground truthing…….. 397

v) Conclusion……401

Bibliography……403

LIST OF FIGURES

1.1 Location of my core and control study areas……31
2.1 Handaxe found at Grays Inn Lane, London in 1679, in association with the remains of a mammoth……..43
2.2 Section B of Rigollot's 1854 excavations at Saint Acheul……49
2.3 Evans' implement groups two and three, later known as handaxes……57
2.4 Worthington Smith's drawing of a woman knapping flint……58
2.5 Restored flint block from Spurrell's 'chipping floor', Crayford……..59
2.6 Obermaier's 1919 map of Palaeolithic Europe……..70
4.1 Sample data sheet……..133
4.2 Fiche signaletique (data sheet) without map reference……135
4.3 Cadastral plan of Sains-en-Amienois showing location of excavation trenches……136
4.4 Distribution of map projections in Europe……137
4.5 Example of a scatter diagram……...148
4.6 Example of the demarcation of interfluves between the rivers Test, Itchen and Meon, South Downs……..149
4.7 Example of disjunction in geological mapping in the North Chilterns between Dunstable and Tring……..153
5.1 Distribution of Chalk bedrock across southern Britain and northern France……..165
5.2 Generalised distribution map of flint-rich gravel at or near ground surface in southeast England……166
5.3 Clay-with-flints distribution north of the English Channel…… 169
5.4 Clay-with-flints distribution south of the English Channel……170
5.5 Loess distribution and thickness in southern England and northern France……..174
5.6 Typical Chalk downland at Hexton, Chilterns……176
5.7 Palaeodrainage maps showing the progressive southward migration of the Lower Thames and relative positions of the Darent and Medway…… 179
5.8 Bridgland's model of river terrace formation……183
5.9 Murton and Belshaw's model of terrace formation……184
5.10 Somme river terraces……186
5.11 Density of solution features on the Chalk of southern England…..199

5.12 Doline formation……..200
5.13a Involutions/cryoturbation structures in Pit A,Caddington, Illustrated by Worthington Smith……...201
5.13b Dissolution pipes in Chalk containing Plateau Drift and lined with darker brown Clay-with-flints *sensu stricto*, M25 Chorleywood (TQ 040 957)……202
5.14 The dry valley network of the Chilterns……..204
5.15 Asymmetric dry valley development……205
5.16 The scarp-face dry valley at Pegsdon, Chilterns (TL 119 301)…..205
5.17 A more typical scarp-face dry valley at Barton Springs Chilterns (TL 088 295)……..206
5.18 Barton Springs, Chilterns (TL 080 290)……..207
6.1 Brickworks around Chesham, Buckinghamshire 1850 – 1860……215
6.2 Hand-digging at H.G. Matthews' Bellingdon brickworks in the 1920s……216
6.3 Position and date of quarries in the Swanscombe area……..218
6.4 Kensworth chalk pit, near Dunstable, Bedfordshire……222
6.5 Dunstable Downs station……..226
6.6 Tring cutting 1839. Watercolour by J. Cooke Burne……228
6.7 Smith's restored road-find from Lower Clapton……231
7.1 Benjamin Harrison aged 60……..246
7.2 Crayford brickearth pits……249
7.3 Spurrell's section of the cliff at Crayford……250
7.4 Henry Stopes……..252
7.5 Worthington Smith indicates a Palaeolithic level in Pit A, Caddington……..256
7.6 Map of the north Chilterns showing location of Worthington Smith's principal sites……257

7.7 Smith's illustration of refitted flakes from Gaddesden Row, showing his labelling system……258
7.8 Dunbridge pit in operation……..263
9.1 Comparative % of surviving Clay-with-flints in each core study area……292
9.2 Relationship between Clay-with-flints survival and findspot density predicted by my working hypothesis……..295

9.3 A linear relationship between findspot density and Clay-with-flints survival……..295
9.4 No relationship between Clay-with-flints survival and findspot density……..296
9.5 Comparative analysis of findspot density and Clay-with-flints survival in all three core study areas…….296
9.6 Relationship between Clay-with-flints survival and findspot density on the North Downs…….297
9.7 Relationship between Clay-with-flints survival and findspot density on the South Downs…….297
9.8 Relationship between Clay-with-flints survival and findspot density on the Chilterns…….299
9.9 Relationship between Clay-with-flints survival and findspot density on the North Chilterns……..300
9.10 Relationship between Clay-with-flints survival and findspot density on the South Chilterns…….300
9.11 Relationship between % Clay-with-flints survival and number of findspots on the edges of Clay-with-flints deposits……..303
9.12 Relationship between number of findspots on Head and % surviving Clay-with-flints on each interfluve……..…308
9.13 Cumulative impact of all late 19th/early 20th century Industrialisation processes on my core study areas……..... 312
9.14 Density of Chalklands Lower-Middle MP dataset entries attributable to gravel/brickearth extraction……..312
9.15 Cumulative impact of differing policies and practices on the finds circumstances of French and British Chalklands Lower-Middle Palaeolithic dataset entries……...350
9.16 Sequence of events through which artefacts have entered the British Lower-Middle Palaeolithic archaeological record……352
A.1 Brick clay stored at H.G. Matthews' brickyard……..390
A.2 Terrain map showing location of survey……392
A.3 Collecting point data for the electromagnetic conductivity survey…….393
A.4 Results of the EM survey with ERT transects overlaid……..394
A.5 Setting out the electrodes for the ERT survey…….395
A.6 Results of the ERT survey……..396
A.7 Plateau drift in Test Pit 1……...398

A.8 Test Pit 2……...398
A.9 The digger excavating Test Pit 4……399
A.10 One of several brick clay extraction pits along transect 2 of the ERT survey……400
A.11 Drone photograph with overlay of ERT transect lines……400

List of Maps

4.1 Example of a findspot distribution map……139
4.2 Distribution map of sites round Amiens (Scale 1:50,000)……143
4.3 Distribution map of sites around Amiens (Scale 1:100,000)……144
4.4 Distribution map for the whole French study area (Scale 1:1000,000)……..145
9.1 Example of transition from Clay-with-flints to Head on a valley-side on the Hampshire Downs……..304
9.2 Gravel pits in the Swanscombe-Greenhithe area……..314
9.3 North Chilterns findspots showing Worthington Smith's sites In blue. All other findspots in red…….327
9.4 South Chiltern findspots, showing Llewellyn Treacher's sites In blue. All other findspots in red…….330
9.5 Darent-Medway interfluve showing Benjamin Harrison's sites in blue. All other findspots in red…….337
10.1 Topographic configuration of the Dagnall to Tring interfluve……..363

LIST OF TABLES

1.1 Variables controlling the formation of the Lower-Middle Palaeolithic archaeological record……27

2.1 Final Palaeolithic sequence of de Mortillet (1900)…….54

2.2 Summary of geological deposits with associated Palaeolithic, pre-Palaolithic and eolithic finds according to Lankester and Moir…….66

3.1 Difference in area requirement per group caused by the effect on population density of moving further from the equator……..90

3.2 Geomorphological criticisms of current interpretations of Middle Pleistocene early human landscape use……119

5.1 Summary of lithostratigraphy of the Chalk of southern England…….164

5.2 Correlation of the Quaternary terraces of the Middle/Lower Thames with the MIS record…….187

5.3 Correlation of the Quaternary terraces of the Middle/Lower Somme valley with the MIS record……..188

5.4 Correlation of Sussex river terraces and raised beaches……192

6.1 Chalk Upland Lower-Middle Palaeolithic dataset entries attributed to gravel/brickearth extraction…….222

6.2 Chalk Upland Lower-Middle Palaeolithic dataset entries attributed to urbanisation……..231

6.3 Comparative data and finds density for each Chalk interfluve measured in 100km^2……..234

7.1 Antiquarian collectors and their impact……..242

9.1 Percentage surviving Clay-with-flints on each interfluve……..293

9.2 Findspot density on the Clay-with-flints and Chalk of each interfluve, calculated per 100km^2 ……..294

9.3 Number of findspots on the edges of Clay-with-flints deposits and their % of total findspots on each interfluve……302

9.4 Number of findspots on Head in relation to % surviving Clay-with-flints on each interfluve……307

9.5 Number of gravel and brick pits mapped onto each interfluve and to which Chalklands Lower-Middle Palaeolithic dataset entries are attributed……..318
9.6 Chalklands Lower-Middle Palaeolithic dataset entries attributable to urbanisation……320
9.7 Chalklands Lower-Middle Palaeolithic dataset entries attributable to railway construction……..322
9.8 Number of total Chalklands Lower-Middle Palaeolithic dataset entries attributable to archaeological fieldwork……345
9.9 Comparative analysis of surface and chance finds and those with no known provenance……348
9.10 Comparative table of total Chalklands Lower-Middle Palaeolithic dataset entries attributable to urbanisation and infrastructure development……349

Chapter One. Introduction.

i) Overview

In this thesis I will argue that geomorphological processes have had a greater effect on findspot distribution patterns than any other external factor and that this has significant implications for their use in interpreting early human behaviour. My research focuses on the Lower-Middle Palaeolithic archaeological record of the Chalk uplands of southeast Britain and northern France and with current interpretations of early human landscape preference based on that record. I use the term 'upland' in the sense of higher-level ground above the river and dry valleys of the Chalklands, rather than the more usual understanding of upland as being those areas of Britain over 250-400m (820-1,310 ft.) in altitude, such as the Pennines, Dartmoor, Exmoor and much of Scotland (www.jncc.defra.gov.uk/page-1436).

Taking a 'Unified Palaeolithic Landscape' approach (Pope *et al.* 2016), I address the imbalance between the perceived significance of the upland and river valley archaeological records and bring the role played by plateau, interfluve and escarpment-edge locations under closer scrutiny. I identify the extent to which bias has been introduced into the Lower-Middle Palaeolithic archaeological record as a result of the processes involved in its creation and consider the implications for interpretations of early human behaviour and landscape preference. Placing geomorphology at the heart of those processes, I consider how all parts of the archaeological record, from all parts of the landscape, have been preserved and/or become visible.

The potential impact of geomorphology on the Lower-Middle Palaeolithic archaeological record has been increasingly acknowledged during the past 25 years and landscape analysis has become as important as artefact distribution patterns. We (Blundell 2016; Pope *et al.* 2015a; Pope *et al.* 2016) proposed a 'Unified Palaeolithic Landscape' Approach (UPLA) to address the structuring of the known Palaeolithic record by considering how all parts of that record, from all parts of the landscape, have been preserved and/or become visible. The UPLA identifies geomorphology as the core control over artefact preservation and release. It argues that, as preservation and release are the primary controls on archaeological

survival, developing an analytical framework which considers archaeological finds within their wider geomorphological context is key to understanding the processes responsible for the formation of the Lower and Middle Palaeolithic archaeological record. Combining landscape distribution, geological processes and the results of site-specific investigations, UPLA suggests that each landscape has its own rhythm of artefact capture and release, controlled by geomorphological processes. Analysis of hand-axe data for the Lower Greensand of Sussex suggests a cycle of <100,000 years before most artefacts become incorporated into mobile Head and fluvial systems. For the Chalk upland solution features and Clay-with-flints a 250,000-year cycle is proposed (Pope *et al.* 2016).

Clay-with-flints is a Quaternary deposit occurring widely across the Chalk uplands of northwest Europe and with a high potential to preserve Palaeolithic archaeology (Scott-Jackson 2000). Formed repeatedly in interglacial periods, it has the ability to set hard in dry conditions and on higher plateaux and interfluves away from the edge the deposits remain, in geological terms, *in situ* (Catt & Hodgson 1976; Scott-Jackson 2000). Upland areas protected by Clay-with-flints have undergone only minor erosion or deposition since MIS 13 so make a good proxy for the preservation of palaeo-landscapes (Catt 1986). The UPLA suggests that, under these conditions, artefact preservation and release and hence the archaeological record, will be strongly controlled by the geomorphology. In this thesis I propose a working hypothesis that treats Clay-with-flints survival as a proxy for the degree of erosion suffered by the Chalk uplands. The hypothesis predicts that where little Clay-with-flints survives finds will mostly have eroded away. Where dense Clay-with-flints survives, finds will be obscured by the geology. Between these extremes there will be optimal conditions for erosional artefact release and recovery. If geomorphology, not human behaviour, is the prime control over recorded artefact density, then the relative abundance of upland findspots should increase and decrease proportionally to Clay-with-flints survival. Testing the impact of differential Clay-with-flints survival on the distribution of the archaeological record for the English Chalklands and contrasting it with the deeply-buried record for the loess-covered French Chalklands forms a key part of my thesis.

Our understanding of early human behaviour always has been and continues to be predicated on a record unevenly distributed in time and space. The Lower-Middle Palaeolithic archaeological record is the result of a number of variables that have affected artefact preservation and release (Table 1.1), meaning the nature of the record varies hugely from findspot to findspot in terms of its quantity, quality and context. Yet within the British planning process and some academic research these distribution patterns are taken at face value and used to formulate interpretations of early human landscape use, with little or no consideration of any potential bias introduced during their creation.

In this thesis I isolate the most significant of the variables affecting the creation of the Lower-Middle Palaeolithic archaeological record and assess their impact on the distribution patterns now visible therein. The variables concerned are geomorphology, late 19th/early 20th century industrialisation, antiquarian collecting and differences between British and French archaeological policies and research strategies. While not an exhaustive analysis of all potential variables, my research nevertheless shows that the shape of the record has been significantly distorted by the processes involved in its creation. This has substantial implications for reconstructions of Lower-Middle Palaeolithic behaviour based on archaeological distribution maps.

The British data used in this research has been compiled primarily from both the online and print versions of Wessex Archaeology's English Rivers Palaeolithic Project (TERPP) and Southern Rivers Palaeolithic Project (SRPP), supplemented and updated by information from Historic England's *Heritage Gateway* database (www.heritagegateway.org.uk/Gateway) the relevant local authority Historic Environment Records (HERs) and the Portable Antiquities Scheme (PAS) database (www.finds.org.uk/database). A number of supplementary sources were also used (*cf.* Chapter Four). The lack of any comparable French resources and difficulties in accessing French data (*cf.* Chapter Four) resulted in a more restricted list of sites for the French uplands. In total, there are 1772 British and 167 French 'sites' in my Chalklands Lower-Middle Palaeolithic Dataset.

A 'site' is simply an archaeological construct, a convenient unit of investigation whose size and shape varies with contemporary knowledge or

Table 1.1 Variables controlling the formation of the Lower-Middle Palaeolithic archaeological record.

Factor	Potential Effects	References
Ecology (faunal, lithic etc. resources)	Concentration of archaeological evidence of apparent continuous short-term or intermittent long-term human activity in resource-rich areas	Antoine *et al.* 2016; Ashton 1998, 2004; Ashton *et al.* 2006; Brown et al. 2010; Hosfield 2016.
Geomorphological processes	Differential preservation or release of archaeological remains depending on geological context; displacement of artefacts from one location to another through periglacial or fluvial processes; differential survival of Pleistocene deposits	Blundell 2016; Hosfield and Chambers 2005; Pope *et al.*2015a, 2016. Scott-Jackson 2000; Wymer 1999.
Land-use history and industrialisation, including large-scale aggregates extraction, urbanisation and infrastructure building.	Differential preservation (e.g. in areas of common land or pastoral farming) and release of archaeological evidence, especially during the period of manual aggregates extraction methods leading to concentrations of antiquarian artefact collecting. Large-scale archaeological excavation during major infrastructure developments – e.g. Canal du Nord; Canal Seine-Nord Europe, HS1; HS2.	Ashton and Hosfield 2010; Ashton and Lewis 2002; Hérisson and Goval 2013; Hosfield 1998, 1999; Wenban-Smith 2013; Wenban-Smith *et al.* 2006; Wessex Archaeology 1993a, 1993b, 1996; White 2016
Antiquarian collecting.	Creation of vast bulk of British Lower-Middle Palaeolithic record, focused on gravel and brickearth quarries from which they collected. Creation of apparent 'supersites' in areas of large-scale aggregates extraction.	Commont 1911; 1916; Harrison 1928; Salomon 1912, 1913; Spurrell 1880a; 1880b; 1883; Treacher *et al.* 1948; Worthingon Smith 1894
Modern fieldwalking and archaeological excavation	Discovery of multiple artefacts in ploughsoil and possible subsequent excavation in extensively walked areas	Ford 1986, 1987; Halliwell and Parfitt 1993; Harp 2005; Parfitt and Halliwell 1996;

research aims (Bowden *et al.* 1991, 107) and 'site' has meant different things to different authors at different times. In France, there are three names with different meanings for what, in English, would all be termed 'sites'. These are *'gisement'* - surface finds or stratified material which has been removed from its original setting by taphonomic processes; *'site'* - a place with several different incoherent occupation levels which cannot be placed in chronological order or absolutely dated; and *'occupation'* - a place with a collection of clearly related artefacts, barely disturbed by taphonomic processes (DePaepe 2010). These situations can overlap and the terms are sometimes, unhelpfully, used interchangeably.

Glauberman (2016) expanded the concept of 'site' to the landform and landscape scale and it is non-site archaeology which is particularly relevant to the Palaeolithic record (Grove 2010). Probably the most relevant definition of a Palaeolithic archaeological 'site' is that it is a location providing evidence upon which inferences about past environments can be built and which contributes to our overall understanding of early human adaptations (Shaw and Scott 2016). Awareness of the palaeogeography and any regional differences in setting is critically important in evaluating Palaeolithic site distributions (Allen 1991; Cohen *et al.* 2012).

Calling a ploughsoil assemblage a 'site' for plotting distribution maps may actually tell us very little about the past (Haselgrove 1985, 14) but in TERPP and SRPP each recorded find is regarded as a 'site' and treated as a single findspot for mapping purposes, regardless of the number of artefacts found there. While the findspot may not be the ideal unit of analysis for derived secondary context archaeology (Hosfield 1998, 267), the same convention has been followed here, for the sake of consistency and because this research is concerned with the controls over the preservation and release of artefacts into the archaeological record, rather than the number of artefacts found or the purpose for which each 'site' may have been used.

To fully understand Lower-Middle Palaeolithic landscape use requires better ways of visualising our archaeological data than simply studying findspot distribution patterns. In this thesis I develop one such method, by breaking the landscape up into individual units and analysing the factors

that have influenced the archaeological distribution patterns within each unit.

ii) Research aims and questions

In sampling terms, the visibility of the Lower-Middle Palaeolithic record is spatially oriented towards the river gravel deposits, especially those high and middle terrace gravels which were dug during the heyday of gravel-digging by hand (Roe 1981). This focus on the river valleys means that some parts of the landscape play little part in the formulation of current interpretations of Lower-Middle Palaeolithic landscape preference, leaving us with a unidimensional picture of the world inhabited by Lower-Middle Palaeolithic people.

In contrast to much earlier work, my research focuses on landscape context and the range of factors constraining the creation of the archaeological record, rather than the artefacts in that record *per se*. Only when careful consideration is given to *how* the spatial distribution patterns in the archaeological record were created can early human behaviour be brought properly into focus.

In my research I therefore aim to:

i) redress the current limited view of Lower-Middle Palaeolithic landscape use by bringing the archaeological record of all parts of the landscape into consideration when interpreting early human landscape preference;

ii) redress the imbalance between the perceived significance of the upland and river valley archaeological records and bring the role played by plateau, interfluve and escarpment-edge locations under closer scrutiny,

iii) test the UPLA prediction that geomorphology has been the first and most influential of the variables impacting on findspot distribution patterns;

iv) identify the major variables that have contributed to the formation of the Lower-Middle Palaeolithic record and assess their impact on the patterns visible in archaeology distribution maps and, consequently, on the implications for using those

patterns as the basis for interpretations of early human landscape preference;

v) identify the differences between British and French Government archaeological policies and strategies and assess their impact on the archaeological record of the two regions.

To address these aims I pose the following research questions:

a) in what ways and on what scale have geomorphological changes taken place in the core and control study areas since the Middle Pleistocene?

b) in what ways, if any, have these changes differed between the study areas?

c) what effect, if any, have the changes had on the archaeology of the different areas and its survival?

d) do high-ground scatters in the core study areas show any uniformity in respect of their geological relationships and are these replicated in the French uplands control area? If so, can the geological context of the surviving archaeology be used to predict the potential location of other sites in southeast Britain and/or northern France?

e) to what extent has the industrial and infrastructure history of each area impacted on the preservation/release opportunities for artefacts and on find spot distribution patterns?

f) to what extent have individual collecting activities impacted on find spot distribution in the core and control study areas?

g) to what extent have differences between British and French archaeological policies and strategies impacted on the creation and shape of the archaeological record in the two countries?

h) what are the implications of all of the above for the use of distribution patterns as indicators of early human landscape preference?

iii) Core and control study areas

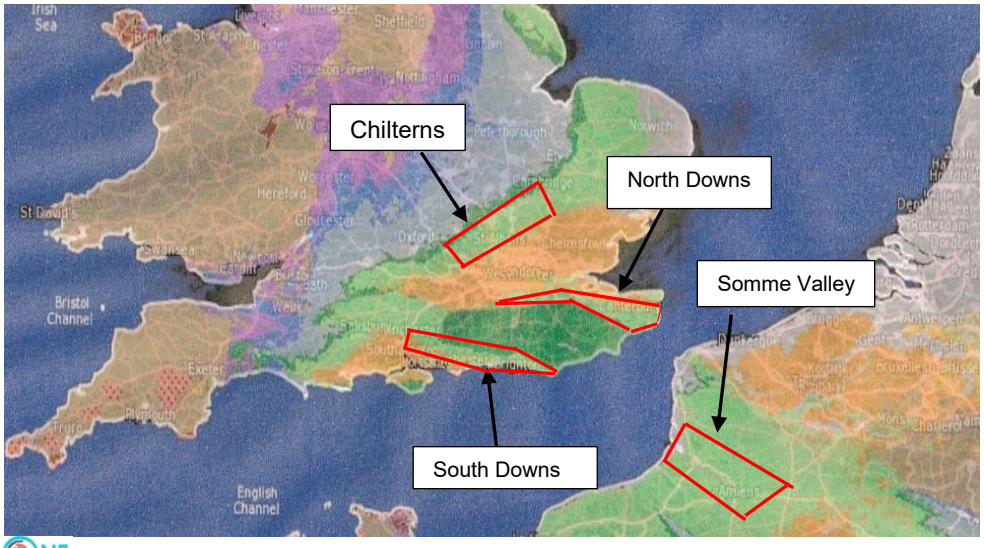
My research focuses on three areas of south-eastern Britain – the Chalk uplands of the Chilterns between the Goring Gap, Oxfordshire and the Hitchin-Stevenage Gap, Hertfordshire; the North Downs between Folkestone, Kent and the Wey-Blackwater Lodden, Surrey; and the South

Downs between Eastbourne, East Sussex and the River Test, Hampshire. It uses the Chalk uplands of the Hauts-de-France région of northern France (focussed on the Somme but including the Aisne and Oise départements) as a control area (Fig. 1.1).

I chose these areas because:

- all lie on the Upper Cretaceous Chalk of north-west Europe so share similarities in their geomorphological histories
- the interfluves capped by Clay-with-flints *sensu lato* (*cf.* Chapter Five) have undergone only minor erosion or deposition for approximately 500,000 years (Catt 1986) remaining stable land surfaces relative to the river valleys and to areas without Clay-with-flints. The general contours of the Clay-with-flints capped plateaux have thus altered little (Catt and Hodgson 1976; Douglas 1976), making it possible to unpick their geomorphology.
- All are situated on the Chalk surrounding river valleys (Thames, Solent and Somme) in existence since the Middle Pleistocene. Both the Thames and Solent have remained broadly consistent in their alignments for at least 55Ma despite the glacially driven southward migration of the Thames. The Solent and Somme remained extra-glacial throughout the Pleistocene (Catt *et al.* 2006. Gibbard and Allen 1994; Gibbard and Lewin 2003).

Fig. 1.1 Location of the core and control study areas



(Map reproduced with permission of OneGeology. All rights reserved).The Chalklands are depicted in pale green. Each of the study areas is outlined in red.

- Although affected to varying degrees by periglacial processes, all were south of, or - in the case of the Chilterns circumvented by - the MIS12 (Anglian) glaciation which, at its fullest extent, reached as far south as a line from Bristol to the Thames Valley. Halted by the Chiltern escarpment between Goring and Hitchin, the ice sheet entered the London Basin from the northeast through the Hitchin Gap, with major lobes extending along the Vale of St Albans and into the eastern part of the Finchley Depression (Baker and Jones 1980; Jones 1981, 182). Nevertheless, although surrounded by the ice, the Chiltern uplands were not overridden meaning that, in common with the other study areas, there has been no removal of the archaeology by surface scouring. There was, however, widespread periglaciation and permafrost in southeast Britain at various times, with marked effects on the Chalk lands (Ballantyne and Harris 1994; Goudie 1990). At times during the Devensian the English boundary between continuous and discontinuous permafrost was close to the present coast of Kent, Sussex and Hampshire and during the Last Glacial Maximum permafrost developed as far south as the Paris Basin (Huijzer and Vandenberghe 1998; Westaway and Bridgland 2010).
- All lie in areas identified as having a high probability of survival of present-day artefact paleosurfaces (Hardaker 2017).
- All are areas in which Lower-Middle Palaeoltithic upland sites have been found and at least a few *in situ* deposits excavated in the recent past, allowing a model developed from the British evidence to be tested against that from northern France
- Wessex Archaeology's TERPP and SRPP provide a comprehensive source of information about the Lower and Middle Palaeolithic of southeast England, allowing the opportunity to systematize and take stock of taphonomic issues before proceeding to the analysis of past behaviour (Gamble 1996b, 64). This data is supplemented and updated by Historic England's *Heritage Gateway* database, the HERs of individual local authorities and the PAS database. There are, unfortunately, no equivalent sources for my Somme Valley control area.

iv) Why study the Chalk uplands?

The Chalk uplands are crucial to a full understanding of early human landscape use in northwest Europe, not least because of the scale of their archaeological record and their potential for preserving genuinely high-resolution archaeology. This has been defined as consisting of sites with excellent preservation not only of the artefacts and objects themselves but also of the integrity of their spatial configurations, which can be presumed to represent organisational aspects of human behaviour rather than of geological processes (Audouze & Enloe 1997). Indeed, Gamble (1995b, 289) argued that the Middle Pleistocene colonisation of Europe took place precisely because the complementary environments of uplands and lowland existed.

Hardaker (2017) proposed a three-step methodology for predicting land-surfaces where Lower-Middle Palaeolithic artefact scatters may survive. By progressively subtracting from the topographic map of Britain glaciated areas, areas covered by superficial deposits masking potential palaeo-surfaces, river basins (because of their volatility) and areas with slopes steeper than ~2º, he demonstrated that the remaining surfaces, those with the highest Lower-Middle Palaeolithic archaeological potential, were mostly the high-level plateaux. As each site is different the predictive map can only be a general guide but clay-with-flints deposits have ubiquitous potential. (Hardaker 2017, 303).

More than 3000 places in Britain have produced Lower-Middle Palaeolithic finds (Wymer 1968,3) the vast majority from lowland river gravel contexts (Brown *et al.* 2013; Wymer 1999, 15). The rest are from raised beaches, caves and lakes or sinkholes. Nevertheless, some of the first Palaeolithic implements in southeast Britain were found not in a river valley, but on the North Downs at Cudham, as early as 1862 (Beresford 2016). Large numbers of isolated finds, surface scatters and a few primary context doline finds have since been made outside the river valleys, primarily on the Chalk uplands of south-east England, northern France and the southern Limburg. Scott-Jackson's unpublished gazetteer of >2000 Lower-Middle Palaeolithic artefacts found in relation to deposits mapped as Clay-with-flints (Scott-Jackson 2000, 27) gives some idea of the scale of this upland record,

making it clear that early humans did not confine themselves to river valleys, lakes and coasts.

As this thesis demonstrates, Lower-Middle Palaeolithic artefact distribution maps suggest that the Chalk downs were favoured areas for early humans, perhaps because they were kept open by grazing herbivores (Wymer 1999, 15) and fresh water from springs and flooded dolines and rich sources of flint were close at hand (Glaubermann 2006). They also provided good opportunities for tracking game in the valleys below (de Warrimont 2007; Drinkall 2013). There is every reason to suppose that artefacts found on these upland sites are in the place where they were discarded, apart from movements in the soil and some dissolution of the underlying Chalk (Scott-Jackson 2000b, 893; Wymer 1999, 16).Surface palaeoliths also occur on the high plateaux of other solid formations such as the Lower Greensand and the Hythe Beds around Ightham, Kent.

Although significantly affected by periglacial processes, the Chalk uplands of my core and control study areas escaped the successive direct glacial scouring that removed surface archaeology in more northerly parts of Britain and northwest Europe. In certain circumstances, even in the volatile British climate, surface scatters may not have been moved far from their original location, the Clay-with-flints having ubiquitous potential for preserving Palaeolithic archaeology (Hardaker 2017). The uplands are also pitted with solution hollows in-filled with fine-grained sediment in which Pleistocene palaeosols, faunal remains and/or archaeology may be preserved, as at Worthington Smith's Chiltern sites, Wood Hill, Kingsdown (Kent), Ferme l'Epinette and Gentelles (Somme).

The dearth of primary context north-west European Lower-Middle Palaeolithic sites means the few which are found assume a greater than warranted significance, becoming thought of as 'representative' of early human activity over tens of thousands of years (Wilkinson 2001). Yet in some respects, high resolution data can be too detailed and relate to too limited a time-frame to allow the tracking of human behaviour occurring at millennial and inter-regional timescales (Pope 2004) meaning low lying primary context sites provide only a limited environmental focus on a world which would have been complex and varied. The very precision of these sites, representing as little as 20 minutes to a few hours, makes them

perhaps unrepresentative of the wide range of behavioural variability (Wenban-Smith 2004b, 49). Although the amount of information available from lithic surface scatters depends on their integrity and whether or not they contain artefacts which are typologically and technologically diagnostic (Schofield 1994) the Chalk uplands thus have an important contribution to make to a rounded picture of early human landscape behaviour. Surface assemblages eroding at plateau and terrace edges may be mixed samples of buried horizons from a large area, so can be considered broadly representative of the range of activities carried out on the Chalk uplands during the Lower-Middle Palaeolithic (Glauberman 2016).

The Chalk uplands of southeast Britain have also been historically significant in the study of Lower-Middle Paleolithic archaeology. During the last decades of the 19th century the North Downs played a major role in the efforts of Joseph Prestwich and Benjamin Harrison to challenge the view that human beings were predominantly post-glacial (*cf.* Chapter Two) and in 1899 Harrison's worn handaxes from the surface of the North Downs near Ash became the first properly contextualised evidence of glacial and pre-glacial occupation to be accepted in Britain (McNab 2009). In 1914, addressing the Prehistoric Society of East Anglia and based on two years work on the Chalk downland between the river Meon, West Sussex and the south of the Isle of Wight, Colonel A.W. Jamieson (1914, 458) stated that the earliest record of the Stone Age was to be found "written not in pits of transported gravel, but at the fountain head and parent source of those gravels – the Clay with Flints of the chalk downs".

Despite this early recognition the hilltop finds were largely ignored during the 20th century and work concentrated primarily on lowland fluvial contexts. The large numbers of upland isolated artefacts and surface scatters have, consequently, played little part in the formulation of currently prevailing interpretations of northwest European early human landscape which are, as a result, based largely on a biased data set drawn from a restricted environmental context. It is clear that river valleys represent only a small fraction of the palaeolandscape and the riverine bias is, potentially, limiting our understanding of early human organisation to a single facet of behaviour (Drinkall 2013).

While the loess-mantled plateaux of northern France are officially recognised as a context within which there is high potential for Acheulean archaeology (Locht *et al.*2010), equivalent plateau locations in southern Britain are viewed as marginal Palaeolithic landscapes with little archaeological potential and there is still a tendency to regard surface survey as "the last refuge of the desperate" (Bowden *et al*. 1991, 112). Despite its historic significance and extensive nature, British upland archaeology is widely regarded as contextless, undated and mostly un-dateable. In contrast, fluvial contexts are seen as extensive, datable and offering localised preservational conditions for fine-grained archaeology (Pope *et al.* 2015). Yet evidence from the Chalk uplands of the Dutch-Belgian border region of the Limburg (Blezer *et al.* 1996; de Warrimont 2007; Kolen *et al.* 1999) northern France (Tuffreau *et al.* 1997) and southeast Britain (Drinkall 2013) has established differences in assemblage types and activity foci between upland and riverine locations. This clearly indicates that surface scatters and the much rarer primary context sites on the Chalk uplands can and do contain information that is absent or less present in the river valleys. To marginalise the archaeological record of the uplands and view the real business of early human activity as taking place in lowland areas, particularly in the river valleys will, therefore, inevitably result in interpretations of early human landscape use which are partial, rather than complete.

Despite the challenges presented by archaeology from time-averaged, sedimentary contexts, these are a complex, cumulative part of the record, with a unique potential for demonstrating land-use patterning that is simply not possible through the intensive study of well-preserved, short-term archaeological signatures (Pope 2004, 46). The Lower-Middle Palaeolithic archaeology of the Chalk uplands has, as I will demonstrate in this thesis, a major contribution to make to the reconstruction of Lower-Middle Palaeolithic behaviour.

v) Thesis structure

The remainder of this thesis is structured as follows:

In Chapter Two I review the development during the 19th and 20th centuries of interpretations of the northwest European Palaeolithic record in relation to human antiquity and early human behaviour and landscape

preference. After consideration of the thinking of the early geologists I examine the exploration of the archaeological record by early British and French pioneers such as Reverend John McEnery, William Pengelly, Gabriel Mortillet and Boucher de Perthes. I then consider the ideas of the ninteenth century collectors such as Benjamin Harrison, Worthington George Smith and F.C.J. Spurrell. Finally, I consider 20th century thinkers such as Vincent Commont, the Abbé Breuil, François Bordes, Derek Roe and John Wymer,.

In Chapter Three I critique current interpretations of early human behaviour in respect of social organisation, population modelling, colonisation patterns and landscape use before considering the limited consideration given in these interpretations to geomorphology and the archaeological potential of the Clay-with-flints. I then consider the implications of the failure of such interpretations properly to take into consideration the effect of these external factors on the creation of the archaeological record on which they are based.

Chapter Four deals with my methodology and explains the basis of the geomorphological model on which the analyses in my thesis are based. In it I explain the definitions, methodological conventions and search terms I use in my research, the sources from which I created my Chalklands Lower-Middle Palaeolithic dataset and their strengths and weaknesses. I explain the creation of my findspot distribution maps, their means of analysis and the subsequent identification and investigation of apparent anomalies, again examining the strengths and weaknesses of my approach. I also explain how I analysed the circumstances in which each find was made – whether as a result of late 19th/early 20th century industrialisation (including aggregates/brickearth extraction, urbanisation, infrastructure development and railway construction) or antiquarian collecting activities and how I assessed the impact of the differing British and French Government archaeology policies and research strategies.

In Chapter Five I consider the Quaternary geomorphology of my core and control study areas, their differences and similarities, exploring the significance of geomorphological processes for the archaeological record and for interpretations of early human behaviour and landscape preference. I examine the formation and nature of the Chalk and look in detail at the

Clay-with-flints and loess superficial deposits which have played such a significant role in the preservation and release of Lower-Middle Palaeolithic artefacts. Finally, I consider factors affecting the evolution of the Chalk landscape during the Quaternary, including periglaciation, formation of solution hollows, development of the dry and river valley networks and the impact of fluctuating sea-levels. Based on all of these geomorphological changes, I conclude with a model of geomorphological change to be used in my research.

In Chapter Six I investigate the industrial history of my core study areas and identify the scale of three elements of the rapid industrialisation that occurred during the late 19th/early 20th century. In this I include the development of the aggregates and brickearth extraction industries, construction of the railway network, urbanisation and infrastructure building. I also analyse the number of finds in each study area attributable to these processes. Their impact on the archaeological distribution maps of each area is analysed in detail in Chapter Nine.

In Chapter Seven I review the lives and work of the most significant early collectors in my study areas and consider their impact on the local Lower-Middle Palaeolithic record. They include Worthington George Smith, Llewellyn Treacher and G.W. Smith for the Chilterns, F.C.J.Spurrell, Henry Stopes, Benjamin Harrison and J.A. Montgomerie Bell for the North Downs and Victor Commont, A. Salamon and E. Vignard for the Somme Valley. I also summarise their collecting areas and dates, their collecting circumstances and practices, their impact on the archaeological record and the number of findspots in my data attributed to them. The impact of three of them - Worthington George Smith and Llewellyn Treacher in the Chilterns and Benjamin Harrison on the North Downs – on findspot density and distribution patterns in their area is analysed in detail in Chapter Nine.

In Chapter Eight I consider the differences between British and French Government heritage management policies and research strategies and assess their actual and potential implications for the Lower-Middle Palaeolithic archaeological record of the Chalklands. I look in turn at the legislative background and administrative arrangements in each country, their archaeological resources at the national and local levels, archaeological approach to major infrastructure projects and the

implications in each case for the management and protection of the Lower-Middle Palaeolithic archaeological resource.

In Chapter Nine I present the results of visualising my archaeological data for each variable in the three core study areas – *viz.* geomorphology (through the medium of % Clay-with-flints survival), industrial history and collector activities. In addition, I present the results of visualising the differences in British and French national heritage management policies and archaeological strategies. These demonstrate that, while all four variables had an influence in shaping the distribution patterns visible in the Chalk upland archaeological record, it was the nature of the original geological deposits and consequent geomorphological changes that were the starting point for all the other processes. Consequently, this had the most significant implications for the use of findspot distribution patterns as indicators of early human landscape preference.

In Chapter Ten I return to the research questions posed earlier in this chapter and consider the extent to which they have been answered. I summarise my results in respect of geomorphology, Victorian industrialisation, antiquarian collecting and differences between French and British heritage management strategies and discuss their implications for the use of distribution patterns as indicators of early human landscape preference. Having made a number of suggestions for future work, I conclude that archaeological distribution patterns in a region can only properly be understood if the starting point for their interpretation is the geological and geomorphological history of that region and that it is only possible to arrive at a fully rounded understanding of early human behaviour when the archaeological record of all parts of a landscape is taken into account.

Appendix 1 deals with my Quaternary Research Association funded survey of ~12 ha. of Chilterns farmland at Bellingdon, Buckinghamshire to test the potential for locating dolines containing primary context Middle Pleistocene deposits using electrical geophysical survey.

iv) Summary

In this thesis I aim to address the perception that the Chalk uplands were marginal Palaeolithic landscapes with little archaeological potential and to bring all elements of the landscape into consideration in future

interpretations of early human landscape preference. I do this by visualising the data in a new way, dividing each study region into individual land blocks and assessing the impact of the variables responsible for creating the distribution patterns in the archaeological record of each block. While not a comprehensive analysis of all the potential variables involved, I deal with those which have been most significant – geomorphology, industrialisation, antiquarian collecting and national policies and strategies for managing the Lower-Middle Palaeolithic archaeological resource. I conclude that geomorphological processes have seriously biased the present-day distribution of artefacts and that geomorphology, not human behaviour, has been the prime control over artefact preservation and release and, hence on distribution patterns in the archaeological record.

Understanding the variables controlling the formation of the Lower-Middle Palaeolithic archaeological record and incorporating all elements of the landscape into consideration in the way recommended in this thesis will enable a deeper comprehension and more rounded interpretations of the full range of Lower-Middle Palaeolithic behaviour.

Chapter Two. Early interpretations of the northwest European Palaeolithic archaeological record.

i) Introduction

During the 19th century archaeology changed from an essentially literary pursuit into a more empirical discipline (Bradley 2002) and antiquarianism gave way to geologically informed professionalism within the natural sciences (Pettitt and White 2011). Early studies of human origins formed part of the17th, 18th and 19th century studies of Earth history, led by the thinking of palaeontologists and geologists. Until the mid-19th century the focus was on the older bedrock geology, rather than the Quaternary superficial deposits (O'Connor 2007) of the Chalk uplands which are the focus of my research and which attracted far more interest once ancient artefacts were found in them.

Palaeolithic archaeology can be said to have begun in the 1690s, when apothecary and antiquarian John Conyers found the Gray's Inn Lane handaxe (Fig. 2.1), in association with the bones of what is now assumed to have been a mammoth (Foulds 2012), though whether it was a true archaeological association is unclear (Roe 1981, 19). It was, nevertheless, the first recorded Palaeolithic discovery in the world (Wymer 1968, 45). For Conyers the handaxe was the weapon of a Briton fighting against the Roman army (Breuil 1951). In 1715 John Bagford, a member of the Society of Antiquaries, speculated it may have been left by an Ancient Britain near the bones of a Roman elephant (O'Connor 2007).

In 1797, John Frere (1740-1807) found numerous flint artefacts ~12 feet below the surface during brickearth digging at Hoxne, Suffolk. Frere described these as "weapons of war, fabricated and used by a people who had not the use of metals" and dated them to "a very remote period indeed; even beyond that of the present world" (Frere 1800, 205). At the time, this statement provoked little response and Hoxne was, temporarily, forgotten. It was not until 1859, following Evans' and Prestwich's confirmation of Boucher de Perthes' finds from Amiens that prehistoric archaeology truly came into being and the finds of Conyers and Frere were accepted (Foulds 2012, 8).

In the early 1800s the generally accepted time-frame for human antiquity was still very short, based primarily on literal readings of the Old

Testament. In 1642-4 James Lightfoot, Master of St Catharine's College, Cambridge, calculated the date of Creation to be 3929 BC and in 1650 Archbishop James Ussher of Armagh dated it to 4004 B.C. There were efforts during the 18th century Enlightenment to argue on a scientific basis against this literal reading of the Bible and to establish the age of the world as being much older, efforts that were resisted strongly by the Church. From his 1693 investigations into the rate of evaporation of water, Edmond Halley (1656-1742) astronomer, geophysicist, mathematician and meteorologist, concluded that the salinity of lakes and oceans must gradually be increasing and that if the rate of increase could be determined, it should be possible to establish Earth's age evidentially. Halley's calculations showed that the figure derived from biblical genealogies was too low and the alternative view that the Earth was eternal was also incorrect. His proposal that accounts of the Noachian Floor might reflect a very close approach of a comet to the Earth caused him to be censured by the Royal Society in 1694 (Complete Dictionary of Scientific Biography 2008).

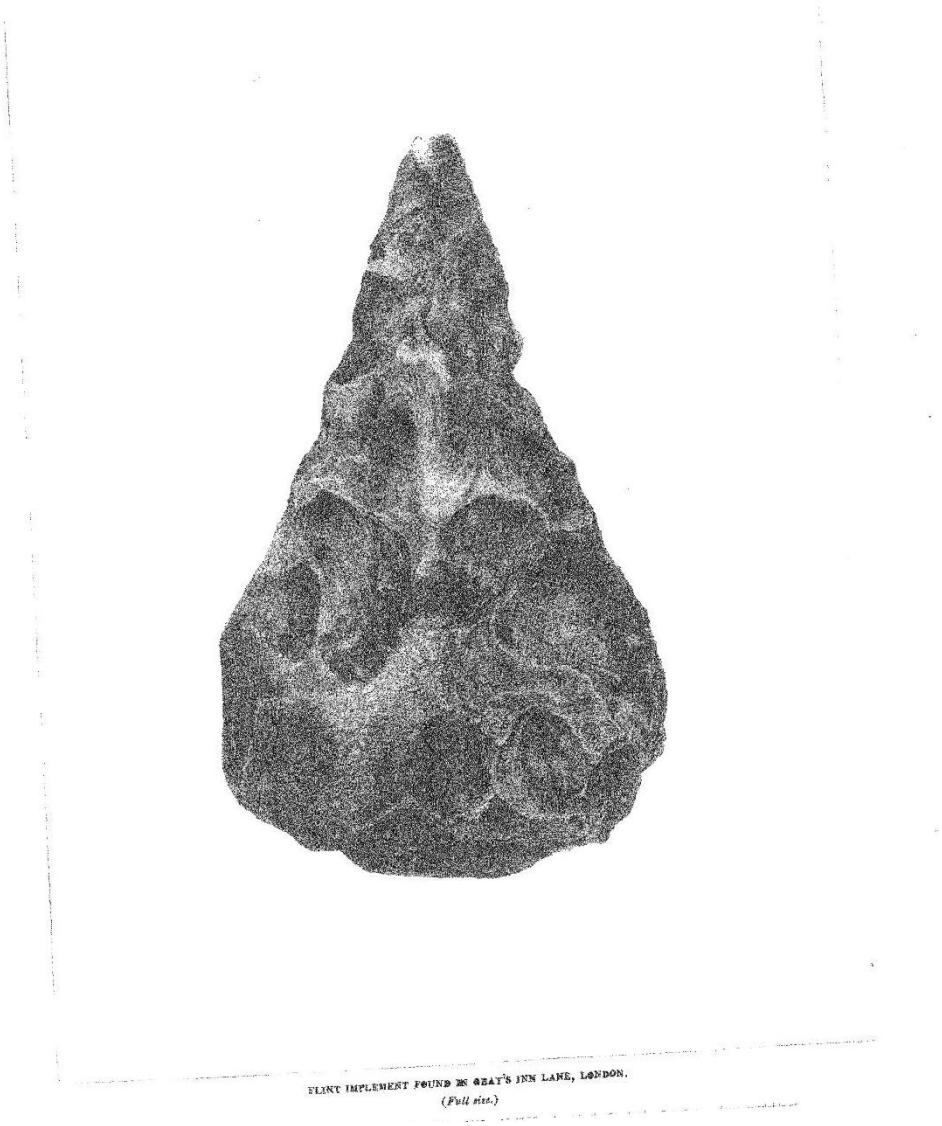
In 1777 French naturalist, encyclopaedist, mathematician and cosmologist Georges Louis Leclerc, Comte de Buffon (1707-1788) published his *Époques de la Nature* in which he calculated the world to be >100,000 years old, based on assumptions about the cooling rate of hot bodies of a known size and temperature and that the Earth was hot at its creation. His work, which was to influence the next two generations of French naturalists, including Lamarck (Burkhardt 2013) and Cuvier, was condemned by the Faculty of Theology at the Sorbonne and Buffon was forced to issue a retraction (Allaby 1999), although he never revised his publications.

Only in the mid-19th century did Ussher's chronology come under increasing attack from supporters of uniformitarianism (see below) and it became generally accepted that Earth was tens, possibly even hundreds of thousands of years old. This finally opened the way for debates about the antiquity of man based on geological, palaeontological and archaeological evidence.

Gamble (2009b) identified three phases in the development of Palaeolithic archaeology - the *heroic age* when prehistoric archaeology was established and the Palaeolithic became a science; *the age of the collector,* with

millions of flint tools found worldwide, allowing detail to be added to the classifications laid down in the heroic age; and *the age of experimentation* when chronologies became absolute and wide variations in technology and typology were established. Interpretations of the European Palaeolithic archaeological record likewise evolved through each of Gamble's phases, as the geological contexts in which artefacts were found changed from cave deposits to river drift and plateau deposits. The archaeological record of the Chalk uplands runs like a thread through all three phases, its importance varying with each, but never insignificant.

Fig. 2.1 Handaxe found at Grays Inn Lane, London in 1679, in association with the remains of a mammoth



(Reproduced from Evans 1861 Plate XVI)

John Evans (1823-1908) observed (Evans 1861, 280) that “geology is, in fact, but an elder brother of archaeology and it is, therefore, by no means surprising to find that the one may occasionally lend the other brotherly assistance” and during the heroic age geological and palaeontological thinking predominated in considerations of human antiquity. Theories of regional and general catastrophism, which envisaged the past as interrupted by a series of catastrophic floods, were followed by uniformitarianism, which identified a single long and geologically uninterrupted period prior to the Noachian Flood. Both believed humans were present in Europe only *after* this event, placing severe constraints on acceptable interpretations of the archaeological evidence.

During the age of the collectors, from 1859 until 1914, drift geology and the upland archaeological record moved to centre stage and the theory of unilateral cultural evolution prevailed. This envisaged that tool types had evolved linearly over time within a single cultural tradition and encouraged the belief that archaeologists could use modern ethnographic cultures to illustrate the ways of life associated with particular epochs. Throughout most of this period, however, the field continued to be led by geologists such as Sir Joseph Prestwich and palaeontologists like William Boyd Dawkins, the leading geological debate being between James Geikie’s theory of multiple glacials and interglacials, and a single glacial model, with post-glacial Palaeolithic artefacts, supported by the majority (O’Connor 2007). Only at the end of the period did professional archaeologists such as Reginald Smith of the British Museum emerge to lead the field, though still working closely with geologists. Throughout the age of the collectors, it was the archaeology of the Chalk uplands that led the way with the identification of *in situ* sites of national importance, such as Caddington (Chilterns) Stoneham’s Pit, Crayford and Swanscombe (both North Downs) and the amassing of vast collections of artefacts by collectors such as Benjamin Harrison and Henry Stopes. Harrison’s eoliths from the North Downs were at the forefront of the debate about Tertiary Man, setting the stage for the Piltdown fraud of 1912.

Gamble’s age of experimentation begins with Hazzledine Warren’s 1914 debunking of the eoliths (Warren 1905;1914) and, for the purposes of this chapter, culminated at the end of the 20th century. By the mid-1920s, the concept of the linear Palaeolithic sequence had been replaced by the idea

of parallel tool-making cultures and during the first half of the 20th century research focused on the construction of chronologies based on artefact variation by people such as Breuil and Bordes. During the latter half of the 20th century the construction of marine oxygen isotope stages and emergence of deep-scale dating techniques provided a means of dating and interpreting the British Palaeolithic without using typological classification (O'Connor 2007) and the emphasis shifted to trying to understand the behaviour behind the tools. The closing decades of the century saw a revival of interest in the Chalk upland archaeological record and acknowledgement of its potential for enabling a full understanding of early human landscape use.

In this chapter I address each of Gamble's phases of Palaeolithic archaeology in turn, examining the development of interpretations of the northwest European Palaeolithic archaeological record during each through the work of the major participants and considering the part played in those interpretations by the archaeology of the Chalk uplands and drift/superficial geology. Interpretations of the Palaeolithic record during the current century are reviewed in Chapter Three.

ii) The heroic age

The Chalk uplands which are the central focus of my research played little part in interpretations of the archaeological record throughout most of the heroic age, when concentration was primarily on the fossil record from cave deposits and Boucher de Perthes' stone tools and faunal fossils were almost totally ignored Their acceptance as genuine in 1859 saw the archaeological record of the Chalk uplands and their superficial deposits move to centre stage at the very end of the heroic age, giving birth to the Palaeolithic.

Catastrophism

In the early 19th century Quaternary researchers began to query the origin and age of the far-travelled 'erratic' rocks, clay and spreads of gravel known as 'diluvium' (because of their association with a supposed great flood) and tried to decipher the relationship between these deposits and the fossil bones of extinct animals (O'Connor 2007).

In his *Époques de la Nature*, Buffon envisaged seven epochs since the formation of the Earth, an analogy to the Biblical seven days of Creation. French geologist and palaeontologist Georges Cuvier (1769-1832) subsequently reconstructed the earth's history from fossil bones, dividing it into six periods, each equated with a Biblical day of creation and distinguished by relatively sudden 'revolutions' in which catastrophic change remodelled the world in progressively more advanced ways.

Cuvier, who established palaeontology as a scientific discipline and whose work inspired Sven Nilsson's early 19th century studies of Scandinavian 'stone age' artefacts (Trigger 2006), viewed the bones of each animal as parts of a system and used his knowledge of comparative anatomy to reconstruct hitherto unknown fossil animals on the basis of what he knew about similar living species. He established that numerous species of animal had become extinct and that older geological strata contained animal remains increasingly dissimilar to those of modern times. Assuming a relatively short passage of time since the creation of the world, Cuvier concluded that a series of regional natural catastrophes had destroyed local species of animals and altered the geological configuration of limited areas - his theory of regional catastrophism (Trigger 2006). He concluded that the very different fossil beasts found in caves and in the gravel beds of ancient rivers were antediluvian, predating the most recent flood to inundate the earth. Without convincing evidence of human bones among such antique species, Cuvier concluded that humans had not existed during this period (O'Connor 2007). Cuvier's friendship with William Buckland (1784 – 1856), Anglican priest and Professor of Mineralogy at Oxford University, and the latter's authority in British intellectual circles, were instrumental in the establishment of progressivism in British natural history and, in particular, the identification of Cuvier's last 'deluge' with the Biblical Flood (Pettitt and White 2011).

With increasing knowledge of the palaeontological record it became clear that many more complex life forms had appeared over time, resulting in geologists such as William Buckland viewing geological catastrophes as universal ones that wiped out almost all species, requiring God to create new ones to replace them – the theory of general catastrophism (Trigger 2006, 141). Like Cuvier, Buckland believed that humans occupied Europe only *after* the land emerged from the flood (O'Connor 2007). The

association of human artefacts with the fossil bones of extinct animals was at the heart of the arguments concerning the antiquity of man. Buckland reflected the ideas of the time, that fossil bones of extinct animals were literally ‘antediluvian’ – the remains of creatures that failed to make it onto Noah’s Ark and drowned in the great flood. Based on his researches at Kirkdale Cave, Yorkshire, he argued that faunal remains found in caves represented generations of animals that had lived and died over thousands of years, their fossilised remains being gathered together by natural processes before being buried by the diluvial clay. Humans, being present only during the last of the catastrophic floods, could not have co-existed with these animals.

Father John MacEnery (1796-1841) excavated in Kent's Cavern between 1825 and 1829, demonstrating the co-existence of extinct animals and humanly worked artefacts beneath undisturbed stalagmite. His results were widely derided at the time as contradictory of Ussher’s dating of the Creation. Although MacEnery’s original excavation report stated unequivocally that he saw no reason why human bones and extinct fauna should not be found together, he struggled to reconcile his findings with the opposing view of his mentors, Buckland and Cuvier (Walker 2009). As a result, in the posthumously published edition of his work, MacEnery concluded that man did not co-exist with extinct mammals (Pettitt and White 2011).

In 1846 William Pengelly (1812-1894), self-taught local mathematics tutor and geologist, explored a small part of Kent’s Cavern (Walker 2009) finding flint artefacts and the bones of extinct mammals beneath the undisturbed stalagmite floor, just like MacEnery. However, the British Association for the Advancement of Science (BAAS) refused to publish these results (Walker 2009) and it was 20 years before work was resumed in the Cavern.

During the 1840s, Jacques Boucher de Crevecoeur de Perthes (1788-1868), a customs officer from Abbeville, Somme, found stone tools and extinct faunal fossils in undisturbed deposits of sand and gravel left by the ancient River Somme at numerous sites in and around Abbeville, on the French chalklands. In 1847, he published his *Antiquités Celtiques et Antédiluviennes*, announcing that the flints he had found were the work of man and in true association with the bones of extinct mammals, all buried

by the Deluge. As a catastrophist, de Perthes concluded that these tools belonged to an antediluvian tool-making race that had been completely annihilated by a massive flood occurring prior to the biblical deluge and that, much later, God had created a new human race. As Noah began his life before the Flood, which he survived, there must have been humans before the deluge and their remains must surely be found (Gowlett 2009).

Initially, de Perthes was largely ignored, but eventually received support from Dr Marcel-Jérôme Rigollot (1786-1854), member of the *Societé des Antiquaires de Picardie*, who in 1854 recovered hundreds of artefacts from gravel beds up to 30m above the current bed of the Somme. His 1854 paper to the *Societé,* concluding that the stone tools were from the same geological layers as extinct mammals, was the first formal acceptance of de Perthes' *haches antédiluviennes* (Gamble and Moutsiou 2011). However, Rigollot died shortly afterwards and his discovery remained unknown, or was considered inconclusive in both France and England, the significance of the Chalk uplands drift archaeology remaining unacknowledged for a further five years.

Uniformitarianism

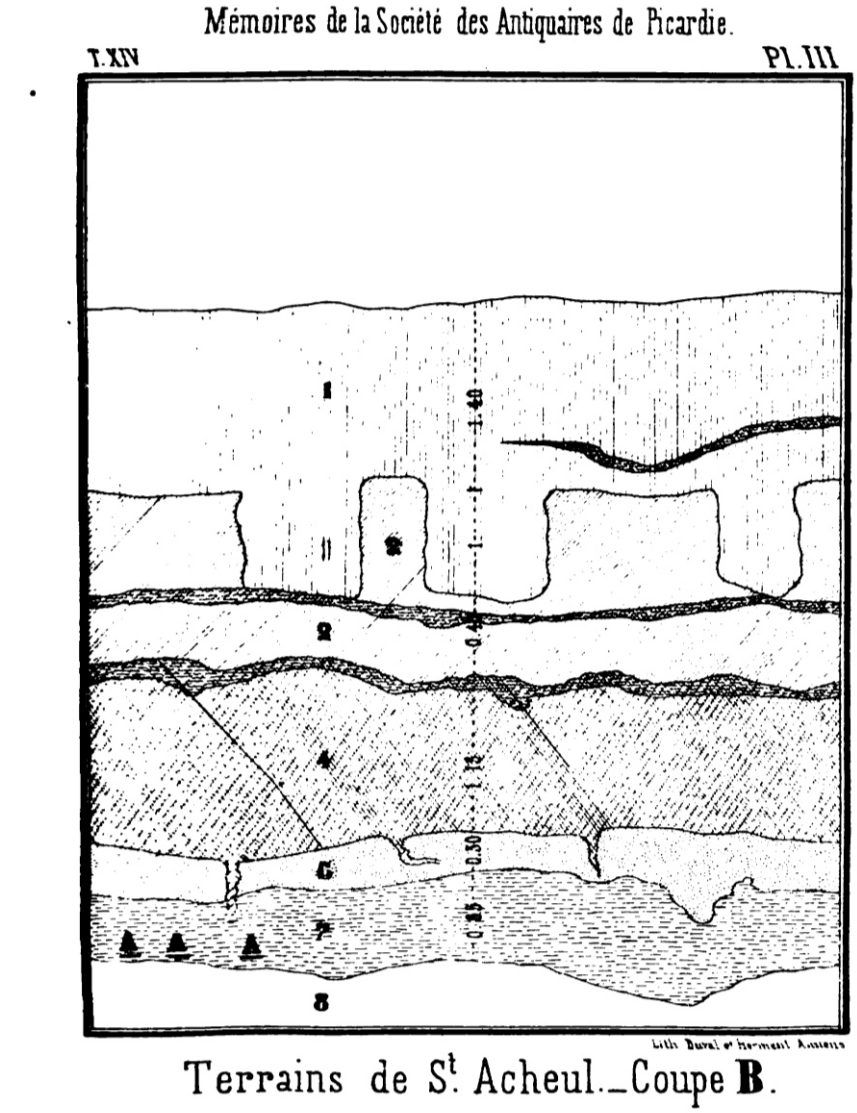
In 1785, Edinburgh physician James Hutton (1726–1797) proposed a uniformitarian view of geological history in which the slow erosion of rocks and soil was balanced by the uplifting of land surfaces, with geological changes occurring in the past as a result of the same natural agencies acting over long periods and at approximately the same rate as they do today. In the years that followed, William (Strata) Smith (1769-1839) in England and Georges Cuvier (1769–1832) and Alexandre Brongniart (1770-1847) in France recognized that each stratum possessed its own characteristic assemblage of organic fossils and that those assemblages could be used to identify coeval formations over large areas. Unlike Cuvier, however, Smith accepted the principle of the orderly deposition of rock formations over long periods of time (Trigger 2006).

Originally a protégé of Buffon, French naturalist Jean-Baptiste Lamarck (1744-1829) was a deist who saw God as the sublime author of nature. In 1802, Lamarck published his *Hydrogéologie*, advocating a steady state geology based on strict uniformitarian principles. He argued that global currents tended to flow from east to west, resulting in a steady progression

of the continents westward around the globe, thanks to erosion on their eastern borders and deposition on their west. Lamarck was also an early proponent of biological evolution and the idea that Nature has successively produced all the different forms of life on Earth, beginning with the simplest and proceeding to the most complex (Burkhardt 2013). In this he came into conflict with Cuvier, who defended the fixity of species.

Lamarck was opposed to the hypothesis of universal catastrophe, coming close in many sections of *Hydrogéologie* to Hutton's uniformitarianism (Carozzi 1964). His use of millions of years as a unit of measurement was half a century ahead of his time. Lamarck made fossil-collecting visits to the

Fig. 2.2 Section B of Rigollot's 1854 excavations at Saint Acheul



Key: 1. brickearth; 2. terre rapportées, full of debris; 3. sandy clay; 4. sandy clay mixed with flint; 4. ferruginous clay; 5.ferruginous clay mixed with flint; 6. pure sand; 7. sandy chalk, mixed with flint; 8. chalky soil at the base. Letters A A indicate where flint artefacts were found. (Reproduced from Rigollot 1856 Plate III)

Chalk and tertiary beds of the Paris Basin 40.23 to 48.28kms (25 to 30 miles) from the centre of Paris and had vast personal knowledge of fossils but unfortunately never grasped some of the basic principles of stratigraphy (Carozzi 1964).

Between 1830 and 1833, English geologist Charles Lyell (1797– 1875) published his *Principles of Geology*, assembling voluminous data to support uniformitarianism and quickly winning support for its principles. Like Buckland, Lyell argued that the bones in caves or fissures might easily have become intermingled during their lengthy accumulation. Despite visiting caves around Liège, Belgium, where possibly coeval human and extinct mammals had been found, he remained unconvinced of their contemporaneity and was equally sceptical about similar evidence from caves in southern France. In 1858, however, Pengelly superintended excavations at Windmill Hill Cave, Brixham, Devon. The cave was hermetically sealed, making it free from the objections levied against Kent's Cavern and other caves that they had been open for centuries and subject potentially to all sorts of disturbance. At the BAAS meeting in Leeds that year Pengelly reported that eight flint tools had been found in definite association with the bones of fossil mammals, vindicating McEnery's findings. The doubts cast on the cavern evidence for the contemporaneity of man and extinct mammals were not fully dispelled, however, until similar discoveries were made in the Chalkland drift deposits of France and England in and after 1859, in circumstances precluding the potential causes of error in caves (Evans 1863, 78).

Despite his uniformitarianism, Lyell rejected the concept of the biological evolution of species. He divided the Tertiary formations into four periods based on their shell content – the Eocene, Miocene and Pliocene (respectively 'dawn', 'less' and 'modern') – adding the term Pleistocene in 1839. These divisions became extremely popular (O'Connor 2007) and the Oligocene was added in 1854 by Heinrich Ernst von Beyrich (Gibbard and Lewin 2016).

The fiercest arguments were about the origin of the distinctive and controversial 'diluvium' (O'Connor 2007), sands and boulder clay deposits supposedly formed by the Noachian Flood. In 1840, Lyell proposed the term 'drift' as an alternative to 'diluvium', in keeping with his theory that

icebergs floating on a frigid sea above a sunken land had dropped the deposits on the sea floor. The rival ‘land-ice’ theory, propounded by the Swiss natural historian Louis Agassiz, saw glaciers rather than icebergs as agents of deposition. In the early 1850s, glacial geologist Andrew Crombie Ramsay proposed two glacial periods, separated by a period of submergence and the idea of a mid-glacial submergence between two phases of glaciation became a popular division of geological time.

During the 1850s Joseph Prestwich (1812-1896), a London wine-merchant with a passion for geology and already known for his work on the London Tertiaries, attacked the notoriously complex Thames Valley drift deposits which, he (Prestwich 1860a) decided, were post-glacial along with the tools they contained. By the 1860s these ‘River Drifts’, which subsequently gave their name to the River Drift culture, were regarded as his particular province (Oakley 1963; O’Connor 2007). The Drift, made up of sands and gravels laid down by rivers or the drifting actions of ice (Evans 1860, 283), contained the bones of extinct mammals. Often the drift deposits were found on the Chalk uplands and in the former courses of rivers, representing their routes when flowing at much higher levels in the landscape, such as the deposits of the Darent valley on the North Downs (Prestwich 1891).

Parallel with Prestwich’s work, Jules Ladrière (1843-1923) produced the first detailed lithostratigraphic systems of the Quaternary silts of northern France (Antoine *et al.* 2011). Quaternary sequences were also built on the fossilized bones of animals and molluscs, leading to fierce arguments about the reliability of different species as chronological and climatological indicators.

The heroic age culminated in 1859 with Prestwich’s and Evans’ visit to the Somme valley to inspect Boucher de Perthes’ excavations and their discovery of an *in situ* handaxe in Pleistocene terrace gravel in a pit at Saint Acheul. Witnessed by Prestwich, Evans and representatives of the Société des Antiquaires de Picardie, the handaxe was found in a section with six feet (1.83m) of surface brickearth, 11 feet (3.35m) of gravel to the axe itself, then 4 feet 6 inches (1.47m) to the bottom of the pit and a further 2 feet (0.61m) to the Chalk (Prestwich 1860a). Prestwich and Evans subsequently identified Frere’s 1797 discoveries at Hoxne brickpit as an

analagous case (Prestwich 1860a) visited the site and discovered handaxes and extinct mammalia (Gamble and Kruszynski 2009). They also became aware of the Grays Inn Lane handaxe (Fig. 2.1) and, even before presenting their results to the Royal Society, convinced most of the main players in the principal learned societies of their results (Gamble 2009b). The archaeology of the drift deposits of the Chalk uplands was, henceforth, significant in debates about the development of man in northwest Europe.

In September 1859, having visited Abbeville, Lyell announced to the BAAS his conversion to the antiquity of man in light of the evidence from there and from Brixham, endorsing his new view of the antiquity of human beings in his 1863 *The Geological Evidences of the Antiquity of Man* (Trigger 2006). However, French opinion remained unconvinced until the 1859 visits to Abbeville by French geologist and palaeontologist Albert Gaudry (Hurel and Coye 2011).

The timing of Pengelly's discoveries at Brixham Cave and Prestwich's and Evan's validation of de Perthes' finds at Amiens was fortunate in that they occurred alongside the Darwinian revolution and the drive by geologists to refute the 'diluvial theory' in favour of fluvial and glacial theories providing a much longer timescale (Gowlett 2009; Roe 1981). However, demonstrating antiquity, not estimating age in thousands of years, was the issue at this point (Gamble and Kruszynsi 2009). For John Evans (1861; 1863) questions about the age of the human artefacts were more geological than archaeological and "the whole tendency of the evidence was to establish a far greater antiquity of the human race than was consistent with our ordinary chronology, though to what extent its bounds were to be transcended remained an open question" (Evans 1861, 280). Prestwich (1860b, 58), while stating unequivocally that flint artefacts and the remains of extinct mammals had been found in association at Saint Acheul, similarly opined that this did not necessarily carry human existence back in time any more than it brought forward the extinct megafauna forward towards the present. The evidence related only to relative, not absolute time.

iii) The age of the collectors.

Unilinear cultural evolution

The acceptance of anthropogenic artefacts in the drift deposits of the Chalk lands had prepared the way for the theory of unilinear cultural evolution. Realizing the Palaeolithic was not a single phase of human development but a series of phases distinguishable by artefact types and their associated fauna, French magistrate and palaeontologist Edouard Lartet (1801–1871) identified four chronological periods or 'Ages', (1) Aurochs or Bison; (2) Reindeer; (3) Mammoth and Woolly Rhinoceros; and (4) Cave Bear, later amalgamating the last two into a Cave Bear and Mammoth Age. Felix Garrigou (1835-1920) later added a still earlier Hippopotamus Age (Trigger 2006) but these divisions were never popular in Britain. Already by 1859, the British Stone Age was divided into three periods on the basis of the different conditions under which stone artefacts were found. These were the *Surface, Cave* and *Drift* periods. Cave and Drift implements were recognised to be much older than surface implements because they were often found in association with the bones of extinct animals or were in or below deposits formerly connected with the biblical flood. In 1865 Sir John Lubbock first proposed the term Palaeolithic for the Cave and Drift periods (Wymer 1968, 45) the Surface implements being Neolithic.

Gabriel de Mortillet (1821–1898) was a geologist, palaeontologist, archaeologist and Professor of Prehistoric Anthropology at the School of Anthropology in Paris. Basing his Palaeolithic subdivisions on cultural rather than palaeontological criteria, he proposed a relative chronology based on variation in artefact form. Each period was distinguished by a number of diagnostic artefact types, the archaeological equivalents of palaeontological index fossils (Trigger 2006). De Mortillet followed geological practice in naming each of his subdivisions of the Palaeolithic after the type site used to define it and relying on stratigraphy to establish a chronological sequence. He introduced still current terms such as Acheulean, Mousterian and Magdalenian (O'Connor 2007).

The underlying rationale behind de Mortillet's scheme was that simple preceded complex. Prehistoric studies showed human progress was a law of nature, with all human groups passing through similar stages of development and this concept of *unilinear cultural evolution* dominated

Palaeolithic archaeology for the rest of the century. This view led also to the idea that the earliest tools, attributed to de Mortillet's Thenaisian and Puycournian Epochs and dated to the Eolithic, would be so crude as to be indistinguishable from naturally broken rocks (Foulds 2012).

Table 2.1 Final Palaeolithic sequence of de Mortillet (1900)

Periods	Epochs
Palaeolithic	Tourassiene Magdalénienne Solutréenne Moustérienne Acheuléenne Chelléenne
Eolithic	Puycournienne Thenaisienne

(Adapted from O'Connor 2007, Table 7.7).

Archaeology and ethnography overlapped in Victorian thought (Bradley 2002, 3) and it was during the 1860s that the notion of a 'primitive' or 'savage' state of humanity first emerged (Pettitt and White 2011). Unilinear evolutionism encouraged the belief that archaeologists could use modern ethnographic cultures to illustrate the ways of life that had been associated with particular epochs.

English banker and naturalist John Lubbock (1834–1913), for example, was deeply committed to the idea of unilinear cultural evolution, arguing that just as modern elephants provide information about the anatomy of extinct mammoths, so modern primitive societies shed light on the behaviour of prehistoric human beings. In his influential *Pre-historic Times as illustrated by ancient remains and the manners and customs of modern savages* Lubbock explained the lack of specific correlations between ethnographic evidence and the western European archaeological sequence as because of environmental factors producing differences in "kind" as well as "degree" among human groups. Technologically less advanced peoples were not only culturally but also intellectually and emotionally more primitive from a biological point of view than civilized ones (Trigger 2006). The parallel Lubbock drew between, on the one hand, Cuvier's reconstruction of extinct species using living species as analogues and, on the other, his own

analogies between “primitive” peoples and “prehistoric” ones was an attempt to enhance the scientific respectability of his cultural comparison.

This concept of cultural inheritance became embedded in both biological and technological heredity. As a result, for the next century, archaeologists became “workers drilled by habit” as they sought to refine typologies and chronologies, rather than question the underlying philosophy (Gamble and Moutsiou 2011, 58). Small wonder that Roe (1981, 271) refers to “the baleful influence” of stone tool typology.

Returning to Kent’s Cavern in 1865, Pengelly identified two distinct groups of artefacts from the two main deposits sealed beneath the stalagmite floor. Tools from the basal breccia were roughly formed on nodules while those from the higher ‘cave-earth’ were predominantly made on flakes and found with bone tools, ornaments and perforated teeth (Pettitt and White 2012a) As a linear evolutionist, Pengelly therefore identified two distinct civilisations, suggesting that the earlier ‘breccia men’ were ‘ruder’ than those who followed (Pengelly 1873, 208).

Other leading proponents of the theory of unilateral cultural evolution were William Boyd Dawkins and John Evans. In his 1874 book *Cave hunting:researches on the evidence of caves respecting the early inhabitants of Europe,* Dawkins suggested the possibility of regional variations in the Palaeolithic and that, over time in Europe, culturally more advanced peoples had pushed aside less developed ones (Trigger 2006, 223, 214). Accepting man’s presence in Britain during the mid-Pleistocene, by 1880 he was persuaded (Dawkins 1880) that by the late Pleistocene ‘River-Drift Man’ was present across a wide swathe of southern and eastern Britain. Nomadic reindeer hunters, equipped only with ‘rude and simple’ tools, the River-Drift people were savages like the native Australians and, based on artefact distribution, they ranged from the Pyrenees to 59^{o} north (Dawkins 1880, 168) following the animal migrations. Although probably pre-glacial and interglacial in Europe, they were definitely post-glacial north of the Thames, occupying Britain south of a line from the Humber to the Severn. What Dawkins had really mapped, however, was the extent of the Last Glacial Maximum (White 2017, 222).

For Dawkins (1880), the Cave-people of the Upper Cave-earth, with their more sophisticated tools and art, significantly post-dated the River Drift

people. He considered, them to be either two distinct races or two sections of the same race which found their way into Europe at widely different times. A northern, probably Neandertal-type tribe, the Cave people had a limited range compared to that of the River-Drift people.

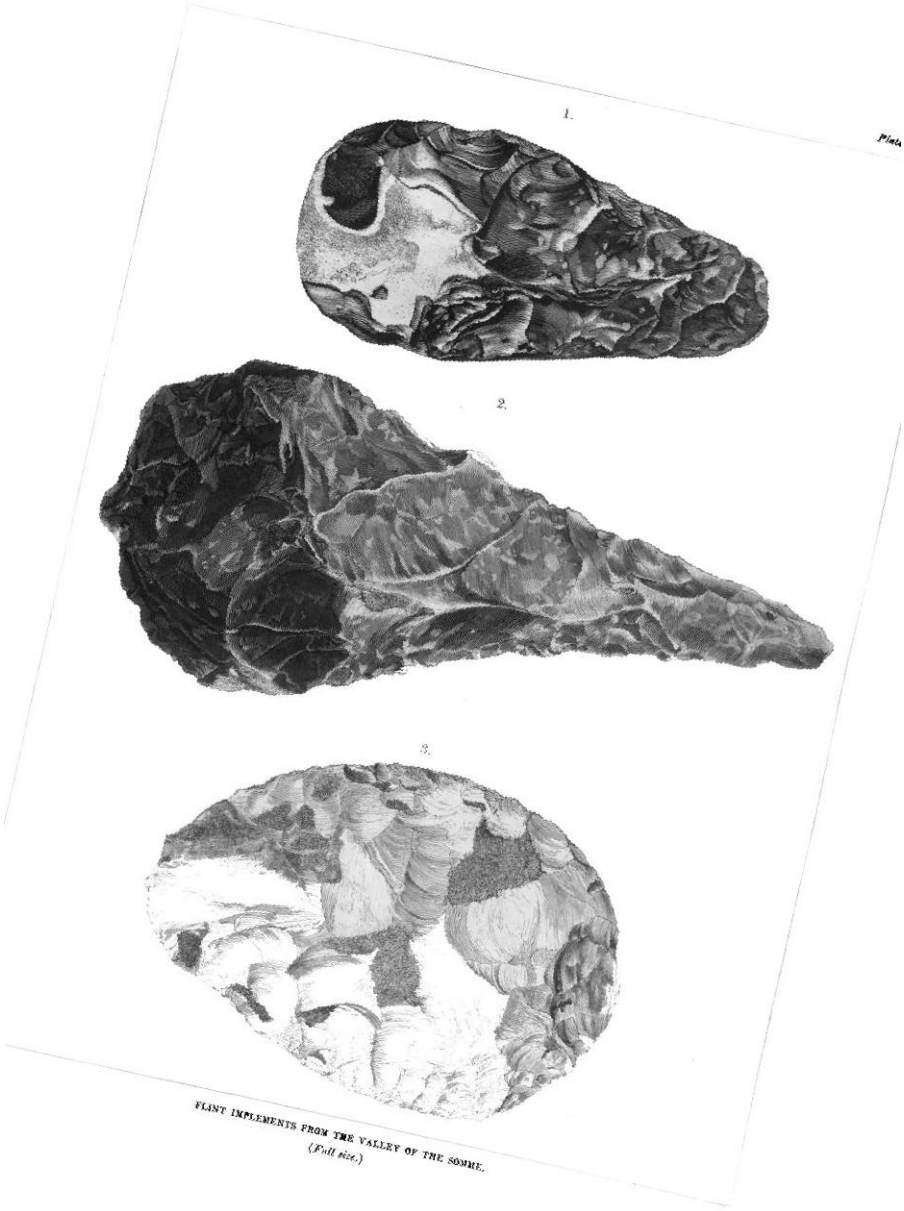
Evans considered the River Drift and Cave peoples to be the same age and race, principally because the associated animals were the same in both river-drift and caves. Based on artefacts from the drift deposits of the Somme valley Chalklands, he (1861; 1863) divided the river-drift tools into three classes - flint flake; pointed weapons with a thick butt; and oval implements with a cutting edge all the way round. Flakes and oval hand-axes were found in the low-level deposits, pointed hand-axes being common at higher levels, showing that tool form had changed over time, becoming more skilfully and carefully manufactured.

The 1880s and 1890s saw a shift from concerns with differences and similarities between river drift and cave artefacts towards an acceptance of Gabriel de Mortillet's 'standard terminology'. This period was also punctuated by the outstanding work of amateur collectors into the tool-making techniques and lifestyles of Palaeolithic man (Hosfield 2009). Working primarily on the drift deposits of the Chalk, their activities saw the upland archaeological record at the forefront of ideas about early human behaviour.

In the Thames Valley, collectors kept watch on the gravel pits, brick-pits, sewers and other exposures in their neighbourhoods that might penetrate the Palaeolithic layers below London (O'Connor 2007). Worthington George Smith, John Allen Brown and F.C.J. Spurrell all discovered *in situ* 'Palaeolithic floors' and reconstructed ancient tool-making methods by re-fitting the flakes together again, Smith and Spurrell becoming adept tool-makers themselves (Scott and Shaw 2009).

For W.G. Smith (*cf* Chapter Seven), after 1885 working almost exclusively on the Chiltern plateau, "By putting known facts together, and by assuming that our savage precursors of far-off times had ideas not very unlike those of savages of recent times, it is perhaps possible to galvanize the fragmentary bones of the primeval savage into temporary life' (Smith 1894, 45-6).

Fig. 2.3 Evans' implement groups two and three, later known as handaxes.



(Reproduced from Evans 1861 Plate XV)

Like Evans, Smith identified three distinct tool classes from southern England, belonging to three different geological ages. The oldest, crudest and most heavily abraded lay deepest in the gravels. The second class, of finely made handaxes, appeared to lie chronologically between the oldest class below and the fresh sharp smaller, artefacts above. A unilateral evolutionist, Smith saw a clear progression in tool-working skill through these three stages (O'Connor 2007).

Smith considered “primeval man” generally kept near the margins of the wide, shallow rivers of southern England, sometimes on “moderate elevations” (Smith 1894, 46). Bestial, dirty and without proper speech “the men of old were one with the animals” (Smith 1894, 53) but still recognisably human.

Fig. 2.4 Worthington Smith’s drawing of a woman flint knapping,

Woman flaking with hammer-stone and flint block on anvil-stone.

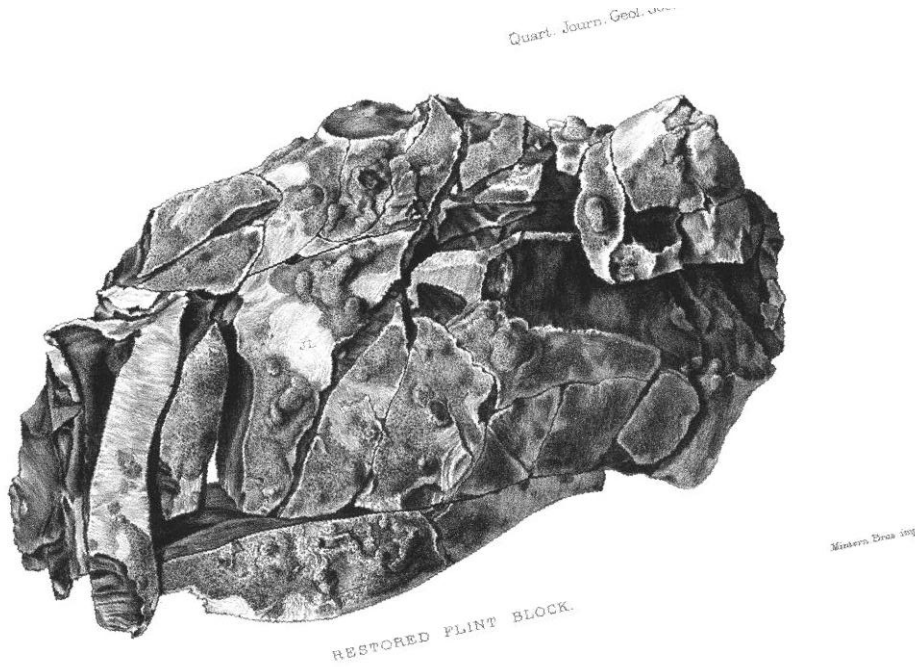
(Reproduced from Smith 1894, fig. 196).

J.A. Brown also discussed the age and habits of the Palaeolithic toolmakers in his 1887 book *Palaeolithic man in N.W. Middlesex*, illustrating them by analogy to the activities of ‘primitive’ living tribes. Accepting the linear evolution evident in Smith’s sequence of tools and emphasising the continuity of Palaeolithic occupation in the Thames valley, Brown suggested tool makers had arrived from Europe as parts of Britain were emerging from the sea after the great submergence (O’Connor 2007). In a paper to the Royal Archaeological Institute in 1893, he argued for a developmental sequence in axes from Palaeolithic types through transitional ‘Mesolithic’ forms to Neolithic axes (White 2017). Identifying distinct groups of implements within the River-Drift artefacts, Brown suggested several waves of tool-makers had entered Britain between the

time of the earliest River-Drift peoples and the Neolithic. His proving ground for these ideas had been the upland archaeology of the Chalk Downs around Eastbourne.

Spurrell, on the other hand, focusing on the Chalk quarries on the North Downs dipslope, was cautious about arranging tools into groups along a Palaeolithic sequence. While accepting some progression in form and broad groupings of artefacts (O'Connor 2007), his real interest was in understanding the mind of the toolmakers (Scott and Shaw 2009). Spurrell's knapping experience also led him to consider what was missing from each sequence, as well as what remained and he noted that the least complete sequences were on better quality raw material, the desired pieces having being carried away (Spurrell 1880a).

Fig. 2.5 Restored flint block from Spurrell's "chipping floor", Crayford



(Reproduced from Spurrell 1880b Plate XXII).

Henry Stopes, a keen collector of stone tools and eoliths, amassed a huge collection including >5000 handaxes, primarily from sites in the Swanscombe and Ightham areas (Wenban-Smith 2009). Another linear evolutionist, Stopes believed the development of human mental capacities could be tracked through ever more sophisticated manufacturing skills. Largely ignoring the geological evidence he displayed his material in

chronological order, developing long sequences tracking the evolution of particular tool types (McNabb 2012).

Llwellyn Treacher (1859-1943) (*cf.* Chapter Seven) believed that although Palaeolithic artefacts could act as "zone fossils" in distinguishing the various deposits of the Thames and its tributaries, the variety in Palaeolithic implements made it difficult to put them into distinct classes or call them by definite names (Treacher 1896b). He doubted the validity of the numerous Acheulean and Mousterian sub-stages proposed in the 1930s (Dewey 1944) and interpreted artefact scatters he found near Furze Platt, Caversham and other places as evidence that Palaeolithic man looked for places where good raw materials were easily accessible, probably on the banks of a stream, knapping artefacts there and leaving large numbers of them along with the waste flakes (Treacher 1896a). More fancifully, a Palaeolithic implement found high above the gravel terrace, at Pinckneys Green, was perhaps lost "while hunting the mammoth on Maidenhead Thicket".

Broad patterns in tool development thus emerged for southern England over the last decades of the 19th century, though with little consensus about the age, origin or appearance of the toolmakers. Some supported an evolution from ape-like stock; some envisaged a very ancient origin for modern humans; and others believed that different races had inhabited Europe (O'Connor 2007, 128).

The eolith debate

It was the eolith debate that saw the archaeology of the Chalk uplands really come into its own as crucial to the debate about human origins. Eoliths were claimed only for countries where flint occurred and never for layers that did not naturally contain flint (Sommer 2004). Late Victorian archaeologists had no real concept of the spans of time they were dealing with and, although Palaeolithic men were considered to be essentially modern human in appearance, they had no idea what Tertiary Man might have looked like (McNabb 2012). The eoliths, manufactured in the Eolithic (from the Greek *eos* [dawn] and *lithos* [stone]), were expected to be primitive and resemble naturally fractured stone because made by primitive peoples (O'Connor 2007).

Claims for the existence of Tertiary humans in continental European sediments had been made several times between 1860 and 1890 but few had been widely accepted (O'Connor 2003). Gabriel de Mortillet was the most prominent supporter of the dawn tools and creator of the term *Eolithique* (Dawn Stone Age), equating to the Tertiary period (Sommer 2004). Lacking skeletal proof of the Eolithic toolmakers, he introduced a hypothetical Tertiary Apeman, *Anthropopithecus*, later called *Homo simisius*.

The first British eoliths ('dawn stones') were reported from the Kent plateau in the 1880s and 1890s by the collector Benjamin Harrison (*cf.* Chapter Seven) and were soon reported also from the South Downs and several places on the Chalk uplands of Berkshire, Hertfordshire, Wiltshire, Hampshire and Sussex (McNabb 2006; Shrubsole 1895). Collecting from plateau drifts around his home in Ightham over the last few decades of the 19th century, Harrison (*cf.* Chapter Seven) garnered box-loads of stone tools, both palaeoliths and eoliths. With no substantial evidence in Britain for the earliest phases of human evolution, the eolith question became a British archaeology of origins (McNabb 2012), prompting questions about who made them, when and where the makers came from and their relationship to the drift and cave peoples.

Joseph Prestwich was one of Harrison's earliest defenders, focusing on the eoliths' unusual position in drift beds up to 600 feet above sea level. Previously, such high-level discoveries had been regarded as accidentally lost post-glacial river-drift implements, a "somewhat desperate theory" (R.A. Smith 1915b) but Prestwich suggested on geological grounds, condition and rudeness, that they were older (McNabb 2009). He saw the Plateau specimens as a series distinct from the river-drift palaeoliths in character and type and divided them into three groups representing a single continuum of variation, all made by the same race of people. By 1891 however, Harrison, who later introduced a transitional form of eolith, an evolutionary bridge between eoliths and palaeoliths, was grouping his collection of 650 eoliths (his "old olds") into different categories according to use (Harrison 1928). He considered them produced by a distinct race of people at the early end of a great evolving sequence of industries (McNabb 2009; O'Connor 2007).

Between 1889 and 1895, Prestwich (1889; 1891;1892) published a number of articles in support of the North Downs eoliths. On 23rd June 1891 he gave a paper before the Royal Anthropological Institute entitled 'On the Primitive Character of the Flint Implements of the Chalk Plateau of Kent' "… a sales pitch for the authenticity of eoliths and their broader implications" (McNabb 2009, 110). After Prestwich's death in 1896, the eolith debate fossilised for a time. However, eoliths were being found everywhere and interest in them reached an international level, at the heart of which sat Benjamin Harrison and his Chalk upland finds (McNabb 2012, 14). Other important scientific personalities, such as Arthur Smith Woodward (1864-1944), keeper of palaeontology at the British Museum of Natural History, followed in Prestwich's place as supporters of eoliths (Sommer 2004),

Benjamin Harrison published little and rarely participated in meetings of learned societies. However, he entered into voluminous correspondence with other collectors and scientists, building up a network of similar individuals (McNabb 2012, 208). Many of these became persuaded of the authenticity of his eoliths, including J. Allen Brown, Henry Stopes (Harrison 1928) and W.J. Lewis Abbott (1853-1933), a Hastings jeweller who extended his studies to geology and archaeology. It was Stopes' support that encouraged Harrison to continue to fight for recognition of his eoliths in face of significant opposition (Wenban-Smith 2009).

A remarkable man, whose name is connected with numerous Palaeolithic discoveries of the late 19th/early 20th century (Wymer 1968) Abbott's mind was "fertile in theory, more so perhaps than balanced in its conclusions" (Anon 1933, 306) and many of his articles "though amusing, must be classed as fiction" (Kennard 1947). A substantial contributor to archaeology, Abbott's most notable contribution in the context of the eolith debate was his discovery in 1880 and 1888 of eoliths in the Cromer Forest Beds associated with the remains of *Elephas meridionalis* (Anon 1933) and in the Pliocene beds at Hastings, Sussex (Abbott 1924). A long-time friend and correspondent of Benjamin Harrison, he was also an active proponent of the anthropogenic origin of the North Downs eoliths. Notoriously publicly outspoken and known to be not above deception (White 2017) Abbott's name has frequently been linked to the Piltdown fraud.

By his own estimation an overlooked genius, others found Abbott eccentric and a reckless enthusiast (White 2017). Among the artefacts from Baker's Hole, Kent, he identified two separate major industries - the 'prestwichian' and its subset the 'evans' (better known as the tortoise cores and flakes of the Levalloisian) and its lineal descendant, the 'ebbsfleetian' (Abbott 1911; Wymer 1968). Abbott claimed also to have identified several different industries from other sites but made no attempt to construct a classification of the British Stone Age industries, arguing that insufficient archaeological evidence had yet become available (Abbott 1911)

Between 1908 and 1912, local solicitor and antiquarian Charles Dawson, discovered a series of fossils belonging to a new type of human in a small pit at Barkham Manor, near the Sussex village of Piltdown. They included a large, human-like skull and robust ape-like jaw, associated with eoliths and a bone tool shaped like a cricket bat, along with a mix of Pliocene and Pleistocene fauna. Many archaeologists had been actively promoting an age of wood or bone predating the transitional examples of flint tools contemporary with *Eanthropus.* Arthur Smith Woodward, (1864-1944) Keeper of Geology at the Natural History Museum, London, friend and former student of William Boyd Dawkins (White 2017) and Dawson's scientific partner in the investigations at Piltdown was a proponent of this view (McNabb 2006; Sommer 2004). The finds were officially unveiled on 18th December 1912 and an ape-like canine tooth was discovered in 1913. For those who believed that Tertiary tool-makers had dropped the eoliths of Kent and East Anglia, the discovery at Piltdown of *Eanthropus dawsoni,* their possible toolmaker, was not surprising.

Following Dawson's death in 1916 no further human remains were found at Piltdown. In 1931, the recently discovered Peking Man (*Sinanthropus pekinensis*) was seen as an ideal link between the two previously irreconcilable forms of *Pithecanthropus* and Piltdown, the simian qualities of the former's jaw answering the doubts of palaeontologists about the Piltdown jaw's association with its skull (Smith 1931,27). The initial success of the forgery can only be understood in terms of the deep uncertainties that existed concerning the true age and evolutionary history of the human species. By targeting the pre-Chellean period the forger was aiming at a black hole within which there was little consensus (McNabb 2006, 37). Over

the years, however, Piltdown became increasingly out of step with genuine finds in other parts of the world and was, finally, exposed as a hoax in 1953.

The Piltdown forgery was embedded in a Sussex/Chalk Downs context, where the emphasis was on Harrison's eoliths and their successors (McNabb 2015, 5), not on Reid Moir's material from beneath the Red Crag in East Anglia (see page 65). This is unsurprising given the geographical position of Piltdown (McNabb 2006). Dawson identified a number of eolith forms from the Piltdown gravels, reminiscent of the types described by Harrison and Prestwich from the Kentish plateau and both rolled and unrolled examples were said to be present with *Eoanthropus* in the lowest stratum of gravel. However, although Dawson may have been an early convert to eoliths, by 1913 he seems to have changed his mind (McNabb 2006). In 1915, at a joint meeting of the Prehistoric Society of East Anglia and the Royal Anthropological Institute, he delivered a devastating attack on both Harrison's eoliths and Reid Moir 's pre-Palaeoliths (McNabb 2015, 8) arguing that all were the result of natural fracture following cleavage along internal planes within the flint (McNabb 2006).

Opinion about Harrison's eoliths ranged from complete acceptance to partial acceptance to complete disbelief, with Boyd Dawkins, Evans and W.G. Smith in the vanguard of the sceptics. One of the fiercest critics of eoliths was S. Hazzledine Warren (1872-1958) who accepted the existence of pre-Palaeolithic man, though not necessarily in western Europe. Warren rejected both Harrison's eoliths and Reid Moir's sub-Crag implements as failing to provide positive proof of his existence. Instead, he attributed their formation to natural processes, which he demonstrated by experimentation (Warren 1905; 1914). Another prominent and outspoken British sceptic was William Sollas (1849-1936), professor of geology at Oxford who was, however, later persuaded by Moir's discoveries of eoliths at Foxhall Hall, near Ipswich (Sommer 2004).

For Evans, Boyd Dawkins and W.G. Smith, Harrison's Kent specimens lacked the diagnostic features of human agency. In 1894, the BAAS funded an excavation by Harrison at Parsonage Farm, Stansted. He found eoliths in the upper eight feet of gravel, but none below this, although the eophiles had hoped they would have been found consistently at great depth

(McNabb 2006). Evans was on the excavation committee but remained unconvinced (O'Connor 2007) and Smith was equally clear about eoliths, declaring "The pre-glacial implements of Britain are not accepted as such by me" (Smith 1894,3). A.J. Montgomerie Bell (*cf.* Chapter Seven) on the other hand, collecting on the Surrey Downs around Limpsfield, was an arch eolithophile (White 2017, 216) who was acquainted with Harrison, with whom he met to discuss their findings.

Eoliths were featured in a number of national and local museums, alongside collections of Palaeolithic and prehistoric material and even the 1902 British Museum's guide to its Stone Age exhibits included eoliths (McNabb 2006; 2012; Sommer 2004). In the early years of the 20th century, James Reid Moir (1879-1944) and Ray Lankester (1847-1929), recently retired director of the British Museum's Natural History Department, picked up the reins from Harrison and Prestwich in the quest for 'Tertiary Man'. The new controversy began in October 1909, with Moir's discovery of some crude flints in the eroded base of the Pliocene Red Crag near Ipswich. Convinced he had found evidence of very early human activity (Moir 1911) Moir informed Lankester, of his finds and Lankester, an authority on the Stoke Bone Bed, became an ardent defender of the sub-Crag flints (Lankester 1912; O'Connor 2007). Moir (1927; 1934) subsequently identified four distinct groups of flint implements within the Bone Bed, the oldest dating back to the Miocene and concluded that before the laying down of the Bed, various races of flint-flaking people had inhabited East Anglia. In 1927, he even went so far as to propose England as the birthplace of mankind (Sommer 2004).

Moir's Crag Pre-Palaeoliths and Rostro-carinates formed a cultural stage midway between eoliths and palaeoliths (Moir 1911, 22). Their anthropogene nature was widely accepted (O,Connor 2007), revitalising the case for Harrison's and Prestwich's plateau eoliths (McNabb 2006), but rejected by Hazzledine Warren and Boyd Dawkins. Reginald Smith of the British Museum was non-committal about their origin (R.A. Smith 2015b). Invited to England to advise on the sub-Crag flints, an initially sceptical Abbé Breuil later accepted their authenticity (Davis 2009) and they were only finally debunked when statistical analysis of the platform-scar angles (Barnes 1943) proved their flaking was because of soil movements under

pressure arising from solifluxion, foundering or ice action (Oakley 1957, 201).

Moir divided the Stone Age into three periods; the New Stone Age (Neolithic), the Old Stone Age (Palaeolithic) and the Eolithic (Stone Age of the Dawn). He argued that Harrison's eoliths were made by a race of ape-like people living in Kent ~1000,000 years ago, his own finds being made by the same people, living in East Anglia (Moir 1927). Via the rostro-carinates, Moir and Lankester connected the English eolith industries to those claimed on the Continent (Sommer 2004).

Table 2.2 Summary of geological deposits with associated Palaeolithic, Pre-Palaeolithic and Eolithic finds according to Lankester and Moir

Geology	Palaeolithic, Pre-Palaeolithic and Eolithic finds
River drifts (post glacial)	Palaeolithic; Chellean; Acheulian; Mousterian
Chalky Boulder Clay	Sketchley's Palaeolithic finds of the 1870s
Middle Glacial sands and gravels	
Cromer Forest Bed (pre-glacial)	Moir's 'implements' discovered in 1918. Considered to be transitional between the sub-Crag rostro-carinates and Chellean handaxes
Red and Norwich Crags	The Norwich test specimen discovered 1911 under the Norwich Crag, a deposit of similar age to the Red Crag; Lankester's favourite example of the rostro-carinate type of sub-Crag 'implement'.
Suffolk Bone Bed	Moir's sub-Crag Pre-Palaeolithic, discovered 1909
Kent Plateau drifts	Harrisons' Eolithic

(Adapted from O'Connor 2007 Table 5.3)

It was Victor Commont (*cf,* Chapter Seven) whose research saw the study of French Palaeolithic archaeology enter the scientific era (Tuffreau 2009). Commont, Directeur of an elementary school in Amiens, recognised the impossibility of separating the study of the Palaeolithic from that of Quaternary geology and, after 1903, devoted all his free time to prehistory and the study of Quaternary deposits on the Chalk lands of the Somme (Commont 1916b,108). From his home in Saint-Acheul he watched the exploitation of quarries and brickyards in the area and in 1905 found knapped Acheulean flints in the lower part of the 'loess anciens' covering

the alluvions of the Somme Middle Terrace in the Carrière Bultel-Tellier (Tuffreau 2001).

Commont also spent considerable time observing the construction of the Canal du Nord, which ran across Picardy and Artois. Based on artefact distributions, Commont interpreted the valley-bottom Mousterian gisements as centres from which people radiated out up the side valleys between Catigny and Sermaize (Commont 1916a) looking for raw material sources and water.

Commont recognized three key lithic industries and their sub-groups in the Lower and Middle Palaeolithic of the Somme: the Chellean, the Acheulean and the Mousterian. The oldest industry was the Pre-Chellean, including crude handaxes and small flake tools, (Tuffreau 2001; 2009). At Montières Commont envisaged mint fresh “coups de poing” (handaxes) found in the calcareous mud at the confluence of the Somme and Selle as being dropped by Chelleans fishing from their canoes or other ancient boats (Commont 1910b).

Commont believed the same race had occupied the Somme valley in Chellean and Acheulean times, the makers of the Acheulean descending from those who made the Chellean. However, in a precursor to the parallel cultural evolution of Gamble’s Age of Experimentation, he suggested the large Levallois-type flakes appearing in the early Mousterian had been made by a different race.

Recognising the dangers of formulating hypotheses based on Eoliths, for Commont the question of Tertiary Man remained problematic (Commont 1910a) He also advised prudence in attributing flint tools to a particular time simply on the basis of their form (Commont 1910b).

Supporters of an Eolithic period were expecting crude tools and found them; their opponents took this rudimentary appearance as evidence for their natural origin (O’Connor 2007, 149). Both the Piltdown forgery and Moir’s English eoliths were without doubt partly motivated by or profited from the fact they finally gave England relics as old as, if not older than those found on the Continent. Piltdown was an attempt to fabricate an ancient human ancestor, as well as the world it came from (McNabb 2006). It was the eoliths of the Chalk uplands which seemed to provide evidence

for those early phases, preparing the ground for the Piltdown hoax. Piltdown Man in turn added significantly to the credibility of the Chalk upland eoliths (Sommer 2004).

iv) The Age of Experimentation

Parallel cultural evolution

British work in the 1900s and 1910s was concerned primarily with identifying a relative chronological sequence for British Palaeolithic artefacts and resolving the number and order of distinct geological periods.

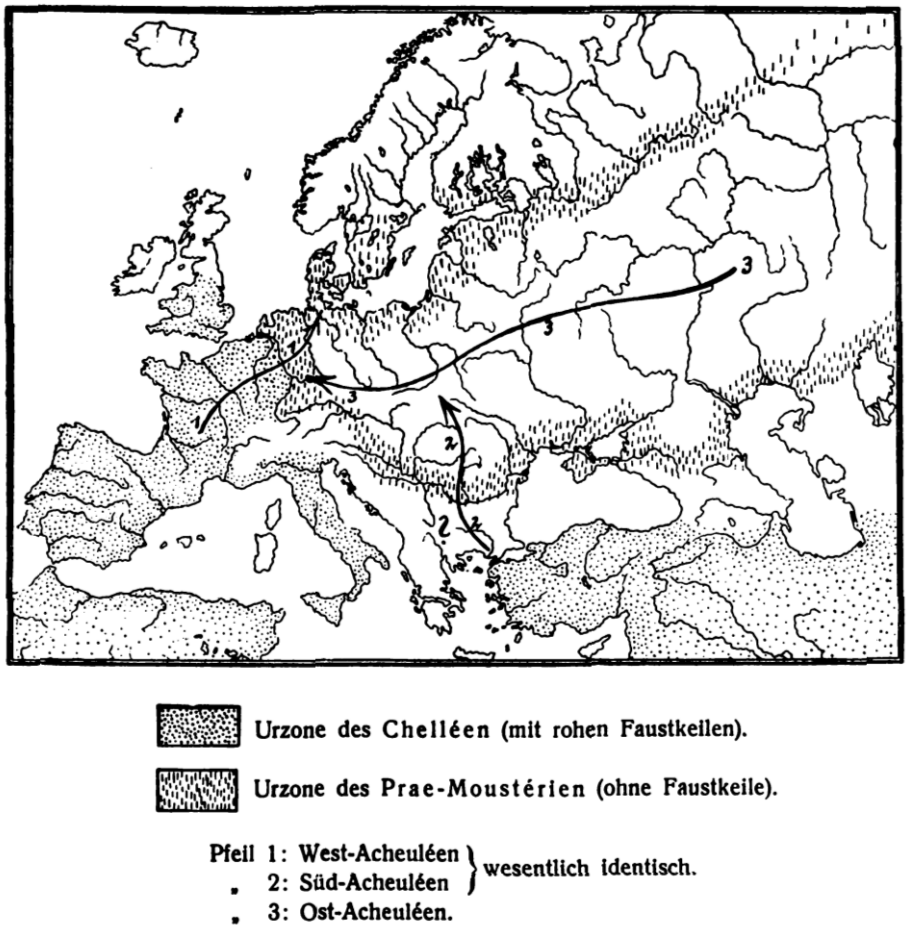
In 1912, when the Associated Portland Cement Company (*cf* Chapter Six) recommenced work at Barnfield Pit, Swanscombe (formerly known as Milton Street Pit) the first multidisciplinary excavation in Britain was conducted at their invitation by "the classic Palaeolithic double-act" (Scott 2010, 79) of Reginald Smith of the British Museum (1874-1940) and Henry Dewey (1876-1965) of the Geological Survey. The aim was to recover a stratified cultural sequence akin to that found on the Continent (McNabb 2015) by Commont in the Somme valley and by the Belgian A.L. Rutot. For Smith, collaboration between geologists and Palaeolithic researchers was the only way to test current Palaeolithic classifications and decide how well the French scheme matched British evidence (O'Connor 2007; R.A. Smith 1915b). The Swanscombe excavations launched an intermittent alliance between the British Museum and the Geological Survey at Barnfield Pit and other Palaeolithic sites in the Thames valley which lasted nearly two years. The Museum was attempting to draw together the Palaeolithic and geological sequences of the Thames Valley and the sequence from the Swanscombe pits proved that different tool types were confined to different layers in the Thames Valley, just as Commont had reported from the Somme (O'Connor 2007). With the publication of their Swanscombe reports (Dewey and Smith 1914; Smith and Dewey 1913) Smith and Dewey established a standard Palaeolithic sequence in Britain (O'Connor 2007). The two continued to work together periodically, their investigations of the Sturry gravels of the Great Stour Valley near Canterbury in the early 1920s (Dewey 1925; Dewey and Smith 1925) again demonstrating that different tool types were confined to different stratigraphic layers.

By the early 20th century, straightforward progression from the Chellean to Acheulean to Mousterian was seen as too simplistic and the 1920s saw British researchers querying the apparent contrast between the continent (where Palaeolithic industries were argued to span multiple glacial and interglacial periods) and the simpler 'home view', (a pre- and post-glacial model). Re-excavations at earlier sites, such as High Lodge, Hoxne and Foxhall Road resulted in widespread acceptance of two British glacials and an interglacial and by the mid-1920s the linear Palaeolithic sequence had been replaced by a general acceptance of the idea of parallel tool-making cultures and of regional variants in Middle and Upper Palaeolithic culture groups (Oakley 1964).

Abbé Henri Breuil tried to place Palaeolithic industries in a precise chronostratigraphic framework based on the Somme terraces, again making the archaeological record of the Chalk lands central to the debate. Despite a general preference for unilinear developmental sequences, Breuil supported multi-linear evolution in the Lower and Middle Palaeolithic, where he saw contemporary, separately evolving "cultural traditions" which reflected ethnicity. For Breuil, the archaeological evidence indicated two hominid groups co-existing in France from earliest times, their technologies evolving in parallel. One group, making bifacial tools, had produced the Abbevillian, Acheulean and Micoquian cultures; the other, producing flake tools, accounted for the Clactonian, Levalloisian and Mousterian. This differentiation between the biface and flake industries completely modified the classification of the Lower Palaeolithic (Breuil 1926; Davis 2009; Tuffreau 2001). Flake industries seemed to appear at the approach of glacial episodes and persist into the beginnings of interglacial episodes; hand-axe industries were truly interglacial, reflecting distinct hand-axe making and flake-making culture groups, periodically pushed into the borderlands of northern France and southern England from their heartlands by cyclical changes in climate (Breuil and Kelley 1954; O'Connor 2007).

Breuil, whose interpretation was based on the work of physical anthropologist Marcellin Boule (1861-1942) and Hugo Obermaier (1877-1946) also made a significant contribution to the British Lower Palaeolithic, particularly the Clactonian.

Fig. 2.6 Obermaier's 1919 map of Palaeolithic Europe



Showing the Chellean zones (with crude hand-axes), the Pre-Mousterian zones (with no hand-axes) and the routes taken by the Acheulian: 1. West Acheulian, 2. South Acheulian (essentially identical), 3. East Acheulian. (Reproduced from Obermaier 1919 Fig. 1)

In the early 20th century Hazzledine Warren (1873-1958) had found large numbers of Clactonian tools near Clacton, Essex and suggested the technology was contemporary with the Acheulean but made by a separate group of toolmakers. This parallel evolution view was rejected by his peers (O'Connor 2007) and it was Breuil who subsequently defined and named the Clactonian, fitting it into his pre-Acheulean phase (Davis 2009). He later claimed to have found it not only in Britain and France, but also in Egypt and South Africa (Breuil 1930).

In 1932, Warren published a list of 11 Clactonian tool-types, ranking them in order of relative importance, with side-choppers in first place. Breuil, on the other hand, stressed the identity of the Clactonian as a flake culture, sub-dividing it into four stages, with a parallel chronological series of handaxe phases (the Abbevillian and Acheulean I-VII). He dismissed

Warren's side-choppers and bifacial forms as retouched nuclei or cores (O'Connor 2007).

Kenneth Oakley was one of a new generation of Palaeolithic researchers sympathetic to Breuil's views and keen to understand the place of the Clactonian in the British Palaeolithic sequence. In a joint report on their 1934 excavations at Jaywick Sands, Oakley and Mary Leakey accepted Breuil's view of Warren's core-implements (Oakley and Leakey 1937) and attempts began to reclassify British industries in line with Breuil's classification. By 1937, the idea of several parallel cultures was widely accepted, making it reasonable to suppose that the Early Clactonian and Acheulean handaxe industries were the products of different racial groups. Based on the differences between the Clactonian industries at Barnham, Suffolk and those of Swanscombe and Clacton, Oakley suggested the Thames Valley and East Anglia were probably two separate and distinct cultural provinces during the Lower Palaeolithic (Oakley and Leakey 1937).

In the 1940s, Thomas Thomson Paterson (1909-1994), Curator of the Cambridge Museum of Archaeology and Anthropology, introduced the idea of *'culture-contact'*. Considering that Lower Palaeolithic nomenclature was "rapidly approaching a state of complete chaos" Paterson (1940, 49), grouped industries that produced flakes from cores within his Clactonian family and industries that produced bifaces from cores or flakes within his Acheulian family, linking the flake cultures to a Palaeoanthropoid line of hominids and the handaxe cultures to a separate Hominoid line, which included Piltdown Man (Paterson 1940). Whereas Breuil had insisted on a clear distinction between handaxe and flake industries, Paterson used the idea of "fusion, by contact, of separate cultural entities" (Paterson and Fagg 1940) to explain the presence of both Acheulian and Clactonian elements in the same tool assemblage. With the existence of parallel cultures, mutual influence and the borrowing of ideas was only to be expected (Oakley and Leakey 1937, 241) and during the 1940s the idea of 'culture-contact' became a popular explanation for the growing numbers of assemblages too varied to fit neatly into Breuil's industrial scheme (O'Connor 2007, 324).

By the late 1940s, despite the huge quantities of artefacts amassed, there was little general agreement on a detailed British Palaeolithic and Pleistocene sequence. Techniques of statistical analysis began to be used

for the objective assessment and comparison of artefact assemblages, with François Bordes (1919-1981) leading the way (Roe 1981). For much of his career professor of Prehistory and Quaternary Geology at the University of Bordeaux, Bordes brought geological expertise to Palaeolithic archaeology and introduced quantification to existing type fossil approaches to the Lower and Middle Palaeolithic. His research on the superficial loess sequences and Lower and Middle Palaeolithic archaeology of the Somme and Seine Basins meant he had little difficulty demonstrating the inconsistencies in Breuil's chronology (Tuffreau 2001, 13) and Bordesian systematics showed that the archaeological record was vastly more complicated than envisaged by traditional approaches to Palaeolithic archaeology (Bisson 2000; Pettitt 2009; Sackett 2014).

Bordes' most significant contribution was in classifying assemblages not on the basis of individual "type fossils" but through the relative frequencies of particular artefact categories. Based solely on morphology (Bisson 2000), he defined 63 tool types that were recurring features of Middle Palaeolithic assemblages and created the classic sub-division of the Mousterian into 5 major industrial groups occurring temporally from after the Rissian/Saalian (MIS8-6) until the arrival of modern humans (Scott 2006). These represented separate archaeological cultures associated with a number of distinct Neanderthal tribes Bordes believed had lived in southern France (Trigger 2006, 255). His simple equation of Lower Palaeolithic = Acheulean = biface industries without Levallois flakes without butt faceting = Riss or pre-Riss; Middle Palaeolithic = Mousterian = industries without bifaces with Levallois flakes with butt faceting = Riss-Würm and Würm remained current until the 1970s and 1980s (Hérisson *et al.* 2016a).

Bordes developed his classificatory scheme of Mousterian variants between 1947 and 1965, although the *méthode Bordes* was effectively in place by 1953 (Bordes 1953a). From that point onwards he developed his scheme geographically across western Europe (Pettitt 2009), recognising additional aspects of Mousterian variability from northern Europe to the Middle East (Bordes 1953a; 1968; 1981). For Bordes, this vast geographical range was the result of convergent evolution and human dispersals from a perceived common origin. The more original variants of the Mousterian found in Central and Eastern Europe suggested centres of

origin independent of western Europe and, like Breuil, Bordes believed that industrial phases recognised through technotypological analysis constituted material expressions of specific ethnic groups (Bordes 1968).

For Bordes. his four main parallel variants of the Mousterian did not interfere with one another to any great extent and the Palaeolithic world was so empty it was unlikely that people of the different cultures would often come into contact (Bordes 1968). He rejected the hypothesis that seasonal variation accounted for the different types of Mousterian as faunal evidence from the cave-shelters of south-west France indicated year-round occupation. He also ruled out seasonal occupation patterns (Bordes 1953a; 1961; 1968; Bordes and Sonneville-Bordes 1970) and dismissed the "antiquated hypothesis" (Bordes and de Sonneville-Bordes (1970) that the different types of Mousterian represented an evolution. They simply represented culturally different ways of performing the same activities with different tool kits (Bordes 1981; Bordes and de Sonneville-Bordes 1970).

McBurney's (1950) study of the Mousterian industries had shown that handaxe sites were confined mainly to the maritime lowlands of western Europe, while non-handaxe industries occurred in the mountainous interior, where ice-age conditions must have been more severe. Whereas the Mousterian industries found in cave-sites in western France were mainly non-Levalloisian, contemporaneous industries in the north were primarily Levalloisian, suggesting that environmental and raw material differences could account for the technological distributions. As a result, it was impossible to be sure whether there really were groups of people with different traditions, or whether different types of Mousterian should be seen as different toolkits within an adaptive framework. Bordes dismissed these hypotheses on grounds that both Mousterian and Levalloisian industries flourished in environments ranging from the periglacial to the sub-tropical, while handaxes were made on a very wide range of raw materials (Bordes 1968). Besides, most of the assemblages he worked with had accumulated over long periods of time without significant change and where real contemporaneity could be established the different cultures could be shown to be contemporaneous (Bordes and Sonneville-Bordes 1970). McBurney (1950) had himself acknowledged that it was difficult to devise a satisfactory explanation for the Middle Palaeolithic distribution patterns in

which ethnic movements westwards from Central Europe did not play a part.

As a general rule, Middle Palaeolithic peoples in France occupied two different environments – caves and rock shelters in southern and eastern France and open-air sites on the loess plateaux of the northwest. For Bordes, this explained their different ways of life and tool assemblages. Levalloisian tribes living in the flint-rich open sites lived a semi-nomadic or nomadic life, leaving behind half-finished tools and flakes when moving on and making new ones at their next site. Semi-sedentary or sedentary cave-dwellers lived in places where flint was scarce, leading to the need to conserve their tools through repeated retouch, following the Mousterian tradition (Bordes 1953b).

Bordes saw a more or less direct relationship between evolutionary changes in the human brain and typological progress (Bordes 1971) and his work has been criticised subsequently (Bisson 2000) for incorporating untested assumptions about Middle Palaeolithic hominid cognition and behaviour into the physical description of assemblages. By assuming that the total morphology of the artefact was behaviourally significant, his typology was “interpretation masquerading as physical description” (Bisson 2000, 2). Nevertheless, it is still the *systѐme Bordes* which underpins the classificatory roots of the discipline (Pettitt 2009). His introduction of statistics to the study of lithic assemblages in 1950 enabled qualitative and quantitative approaches to be used simultaneously and the ‘Bordesian era’ has been defined (by Sackett 1991 cited by Pettitt 2009) as the period when Palaeolithic archaeology entered modern times.

Bordes paid particular attention to dismissing Lewis Binford’s argument that, rather than being the detritus of different cultural groups, the different types of Mousterian should be seen as different toolkits within an adaptive framework – i.e. specialised activities took place at different site types over long periods of time (Bordes and Sonneville-Bordes 1970; Bordes 1981; Johnson 2010). It was Mousterian variability that kick-started Lewis Binford’s promotion of the ‘New Archaeology’ and the so-called Mousterian debate between Bordes and Binford raised the basic issue of how to distinguish in the prehistoric archaeological record between activity and ethnicity, task and group – i.e. between what was going on and who was

doing it? (Sackett 2014, 7). With Binford as its most famous proponent, the 'New Archaeology' school of thought had a major impact on European Palaeolithic archaeology. Driven by a dissatisfaction with traditional cultural history archaeology on the grounds it was not scientific or anthropological enough, it sought to replace 'culture history' with 'culture process' (Johnson 2010). New archaeologists looked much more critically at sampling theory and techniques and queried whether archaeological 'cultures' of the kind envisaged by Dawkins, Breuil and others, had any relationship to real human communities. Subsequently termed processualism, New Archaeology was itself in due course replaced by post-processualism, a crystallization of concerns raised in the 1980s and 1990s that ceased to have much meaning about 2000 but has gone on to inform archaeological thought as a whole (Johnson 2010).

Despite the early recognition of the significance of upland archaeology with the acceptance in 1899 of Harrison's Kent plateau palaeoliths as the first properly contextualised evidence of pre-glacial and glacial activity in Britain (McNabb 2009), except for Worthington Smith's Chiltern sites, the hilltop finds were largely ignored during the 20th century, when work concentrated primarily on lowland fluvial contexts. During the closing decades of that century, however, there was a renewed interest in the upland archaeological record, especially in the higher landscape of the Dutch-Belgian border area of Southern Limburg (Groendijk and de Warrimont 1985; 2007; Kolen *et al.* 1997) and with the work of Dover Archaeology Group on the eastern North Downs in Kent (Halliwell and Parfitt 1993; Parfitt and Halliwell 1996; 2002). Derek Roe first became aware of the Clay-with-flints of the Chalk uplands during the 1960s, while compiling his *Gazetteer of British Lower and Middle Palaeolithic sites* (Roe 1978,ix; 1996, 4) and noted the potential of Smith's Caddington site. Considering the archaeological record of the Chalk uplands had significant potential for essentially *in situ* evidence of purposeful human presence on those uplands (Roe 1981, 184; 1996) he encouraged his Oxford students to investigate the upland record further. In 1971, together with two former students, Garth Sampson and John Campbell, Roe excavated at Caddington in search of at least a remnant of Smith's primary context floor. Although this search failed, Sampson and Campbell subsequently carried out in-depth investigations at Caddington which included study of the local

geology, sedimentary analysis of the deposits, obtaining pollen samples for analysis and detailed study of Smith's original artefacts and documentation (Roe 1978; Sampson 1978). Further reconsideration of Smith's sites took place during the 1980s and 1990s (White 1997; White *et al*. 1999; Wymer 1980). Scott-Jackson (1992; 2000), another of Roe's Oxford students, compiled an (unpublished) gazetteer of >2000 Lower-Middle Palaeolithic artefacts found in association with deposits mapped as Clay-with-flints, and conducted a 1993 case study excavation on the North Downs at Wood Hill, Kent. For Scott-Jackson, a full understanding of the movements and behaviour of Palaeolithic people required consideration of the whole landscape and human occupation of the Chalkland hilltops of southern Britain provided a dimension to the Palaeolithic archaeological record which had yet to be fully appreciated. Scott-Jackson's work is explored in detail in Chapter Three.

In the early 1990s, English Heritage (now Historic England) funded two large-scale projects administered and managed by Wessex Archaeology, with John Wymer as the Project Team Leader. The primary objectives of the *Southern Rivers Palaeolithic Project* and subsequent *English Rivers Palaeolithic Project* were to identify as accurately as possible the findspots of Lower and Middle Palaeolithic artefacts and their geological context to demonstrate the distribution of known Palaeolithic sites in Britain; and to chart the relevant Quaternary deposits. The aim was to secure better protection for Palaeolithic archaeology during planning applications for and implementation of aggregates extraction. These projects provided the starting point for the data used in my research and are described in detail and critiqued in Chapter Four of this thesis. Drawn largely from Roe's 1968 *Gazetteer* (Wymer 1996) they included both upland and river valley sites/findspots, treating them as equally of value. In his seminal 1968 *Lower Palaeolithic archaeology in Britain*, Wymer's focus had been on fluvial sequences but by 1999, while still making the case for some of the most favoured areas for early human occupation being at the confluence of rivers, he considered the Chalk downlands were also favoured areas (Wymer 1999, 15). The prolific surface finds from the Chalk Downs and those from the Head deposits in coombes, valleys and solution hollows were not a coincidence of chance or discovery, but reflected a genuine

choice of this type of landscape when conditions were suitable during various times (Wymer 1999, 165).

v) Summary

In this chapter I have reviewed the development of interpretations of the northwest European Palaeolithic archaeological record, from its beginnings in the early 19th to the end of the 20th century. I have done this by taking Gamble's three ages of archaeology – the *heroic*, the *collectors* and *experimentation* – in turn and considering the significance accorded to the Chalk uplands archaeology during each.

Interpretations of Palaeolithic archaeology prior to 1859 were dominated by geologists and palaeontologists, with Cuvier's regional and Boyd Dawkins general catastrophism theories succeeded by Lyell's uniformitarianism. Both were based on a succession of divinely inspired inundations and, in both cases, humans were envisaged as only present in Europe after the last Noachian Flood (Oakley 1963). Post-1859, the concept of unilateral cultural evolution emerged, with its successive River Drift and Cave peoples occupying Europe, and its logical corollary of the search for Tertiary Man, which rumbled on into the 20th century. Conceptually, the Tertiary eoliths sat at the very root of all evolutionary development in material culture (McNabb 2012,14), The development of long, multi-period sequences of typological evolution with eoliths situated at the base of the tree, located the archaeology of the Chalk uplands at the very heart of interpretations of the archaeological record. Breuil's division of separate flake and handaxe technologies, produced by different ethnic groups, introduced the concept of parallel cultural evolution which was only seriously challenged in the later years of the 20th century (Hérisson *et al.* 2016a). The closing decades of that century saw a revival of interest in the archaeology of the Chalk uplands and the recognition of its potential.

Starting with Boucher de Perthes' 1840s finds in the ancient gravels of the Somme, the archaeology of the Chalk upland drift deposits played a significant role in earlier interpretations of the northwest European archaeological record, albeit to varying degrees at different times, My research will demonstrate that, unless the upland archaeology is taken fully into account when interpreting findspot distribution maps, then an, at best, partial and at worst distorted picture of early human landscape use will be

seen. In the next chapter I will review the extent to which current archaeological interpretations of Lower-Middle Palaeolithic human behaviour and use of their environment do, or do not take account of that full picture.

Chapter Three. Current interpretations of early human landscape use and behaviour.

i) Introduction

Wenban-Smith (2004b, 48) identified two aspects to the archaeological reconstruction of behaviour - narrative of place, centred on a site and focused on the identification of activities at that location and its changing use history; and narrative of landscape, focused on the integration of pinpoint evidence from different places into a wider pattern of variability, behaviour and adaptation across a landscape. The issue of scale in archaeology is intimately related to the notion of the site as the focus for excavation which, historically, blinded researchers to the importance of regional ecological context. The development of site catchment analysis in the early 1970s began to address this problem, feeding into the 'off-site' approach of the late 1970s and early 1980s (Grove 2010). The concept that the landscape rather than the site may be the most viable unit of analysis in reconstructing prehistoric landscape use was implicit in Isaac's (1981) 'scatters and patches' approach yet, prior to the 1990s, archaeologists continued to concentrate largely on narrative of place, the analysis of archaeological assemblages in their local setting, attributing local variation to local factors. However, we cannot understand past behaviour just by reconstructing individual actions (Gamble 1996b) and it is at the scale of landscapes and colonising territories that we see the clearest evidence for the social character of Middle Pleistocene behaviour.

During the past 25 years, the focus of Palaeolithic archaeology has shifted from narrative of place to one of identifying spatial distribution patterns in the archaeological record on a regional scale and interpreting these in terms of human landscape preference. One of the main research trends in northern Europe has been the mapping of human presence and absence and how this has been affected by climate, environment and, in the case of Britain, recurrent changes in status from peninsula to island (Ashton 2016; Ashton & Lewis 2002; Gamble 1987; Roebroeks *et al*. 1992a; White & Schreve 2000). Questions posed by archaeologists have been concerned primarily with changing access routes and populations sources, as seen in the archaeological record (Ashton and Hosfield 2010; Ashton *et al.* 2011; Ashton *et al.* 2015; Ashton *et al.* 2016; Bates *et al.* 2014; Chauhan *et al.* 2017; Davis *et al.* 2016; Scott and Ashton 2011; Scott *et al.* 2010; Scott *et*

al. 2011; White *et al.* 2006). They have increasingly been answered in partnership with Quaternary scientists from other fields, such as soil scientists, social anthropologists, zooarchaeologists and geologists.

There has also been a recent upsurge in the use of social theory to interpret Palaeolithic archaeology, an attempt to understand the material record in terms of the social relationships it helps forge. This has resulted in a shift in analytical perspective (Foulds 2012). Dunbar's (1998) Social Brain Hypothesis (SBH) demonstrated the constraints imposed on group size by executive cognitive capacity and the information processing capacity of the primate (including human) brain (Dunbar 1998; Dunbar and Schultz 2007). The SBH states that individuals living in stable social groups face cognitive demands that individuals living alone or in unstable aggregations do not, that ecological problems are solved socially and that the need for mechanisms that enhance social cohesion drives brain size evolution.

During the 1990s, Gamble (1993, 1996a, 1996b, 1998, 1999) redefined the focus for the study of Palaeolithic society through the individual, the creation of networks and the role of performance in social life. His adoption of the SBH network approach to Palaeolithic society facilitated the comparison of the social systems of extant primates, modern hunter gatherers and archaeologically documented populations within a single framework (Grove and Dunbar 2015, 15). This widening of the archaeological perspective from local to regional set the tone for much of the research carried out during the 21st century.

In this chapter I review the interpretations of early human landscape use that have emerged as a result of this widening perspective, including models of social organisation, population, colonisation patterns and behaviour. The disparate preservation of Pleistocene sediments, the random nature of sediment exposure through quarrying, antiquarian collecting, urban expansion and infrastructure development have all played important roles in shaping distribution patterns in the archaeological record. My primary purpose in this research is to assess the impact of geomorphological processes on the creation of that record and the distribution of Wenban-Smith's 'pin point evidence' across the landscape. In this chapter, however, I focus on critically assessing current interpretative models of human behaviour in the context of the Unified Palaeolithic

Landscape Approach (UPLA) and the extent to which those models consider or ignore the potential significance of geomorphology for the archaeological record on which they are based.

ii) Social organisation

Preferring to think about Middle Pleistocene behaviour within a framework of space-energy relations (Gamble 1987: 95), Gamble saw the Palaeolithic artefactual record as being made up of two different site types, 'Flagships' and 'Dredgers' capable of different scales of analysis. The rare *in situ* 'flagships' can provide detailed information - e.g. the brief primary context knapping episode at Caddington – that can be related to an ethnographic scale of analysis. The far more common 'dredgers' are the rolled handaxes and flakes from secondary deposits forming palimpsest assemblages understandable only through time-averaging over tens of thousands of years. Both types of site are important and it is only by 'tacking' between the different levels/scales of analysis appropriate to each preservational situation that an understanding can be reached of the scale of past behaviour as preserved in the archaeological record (Gamble 1996b).

Local Hominid Networks and Social Landscapes

For Gamble, Middle Pleistocene behaviour was routinized, varying only in response to the selective pressures exerted by the presence/absence of raw materials, food, water and other hominids (Gamble, 1995a; 1996b). Three networks – intimate (significant others), effective (colleagues/friends) and extended (acquaintances and friends of friends) – are derived from the emotional, material and symbolic resources available to individuals to produce their social lives and each of these networks has a consistent demographic size (respectively 5, 20 and 100-400) based on rules resulting from the social use of those resources (Gamble 1998). Gamble identified two spatially and temporally based concepts – the Local Hominid Network (LHN) and the Social Landscape (SL) - the different dimensions of which could be established from archaeological data by the distances over which raw materials were commonly transferred (Gamble 1995a, 22). Based on raw material transport distances in Middle Palaeolithic southwest France, LHNs had an operating radius of 40km (24.9mi), within which all activities could be viewed as 'local' in terms of their social and organisational implications. Transport distances farther than this occurred only rarely and

items indicating long-distance exchange – e.g. shells, ivory, obsidian – were lacking entirely.

The use of lithic transport distances to estimate home ranges has been described (Churchill *et al.* 2016) as being perhaps too simplistic and resulting in highly variable estimates of Middle Palaeolithic territory size. Their attempts to use carnivore ecology models to estimate Neanderthal home-range size led, nonetheless, to a general concordance between the smaller home ranges estimated by lithic raw material transport studies and the territory size of Grey wolves (*Canis lupus*). Both, however, depend on multiple assumptions that are tenuous and difficult to test, rendering definitive figures for Neanderthal home range size impossible.

Gamble's (1995a;1996a; 1996b; 1998) LHN was a 'landscape of habit', common to all hominids. Centred on the individual, whose environment it was, it contained not only other hominids, but also non-hominid competitors and resources, encompassing both subsistence and social behaviour. This concept differed in several important ways from that of site catchment analysis, previously used widely in prehistoric archaeology. In particular, it expected early humans to potentially exhibit a variety of social behaviours, rather than being essentially the same; and it took a different view of how early humans used space, regarding their environment as being constructed as a result of mobility - not surface-area territories, but *paths* and *tracks* between places where resources were encountered (Gamble 1996a;1998).

Social life based on interaction occurred throughout the Palaeolithic but what changed over time was the character and extent of the regional scale. With the appearance of Gamble's Social Landscape (SL) between 100ka and 60ka, the focus changed to the group and social systems were stretched across space and time, not just by interaction but by the possibility of interaction (Gamble 1998). The main point about the SL was that it tied several LHNs together through both actual and potential negotiation and interaction (Gamble 1996a, 260). Where the LHN was local and exclusive of strangers, the SL was inclusive, a network of distant relatives and comparative strangers, with no limits to its spatial dimensions. Based on archaeological information about artefact transport distances, the SL was a late development in human prehistory, first appearing ~50,000ka

with the beginnings of long-distance transport and the first use of antler, bone and ivory for display and as symbolic markers in the environment (Gamble 1996a, 262).

Gamble subsequently turned his attention to analysing the social data contained in archaeological evidence, adopting the Social Brain Hypothesis (SBH) approach to understanding social evolution during the Palaeolithic (Gamble 2009a; 2013; 2018; Gamble *et al.* 2011; 2014). It is only among primates, including hominins, that a quantitative relationship exists between social group size and relative brain size (Dunbar and Schultz 2007; Gamble *et al.* 2011) and for Gamble this can be tested archaeologically. Fission-Fusion groups must practice either periodic aggregation of the whole community or regular fluid exchange of individuals or there can be no overarching community to which all belong. These different systems lead to alternative spatial patterns of aggregation and dispersal and thus to different signatures in the archaeological record (Grove and Dunbar 2015).

Gamble considered (1998) that an initial scaling up of social groupings coincided with the appearance of prepared-core technology ~300 ka. Between 0.6 and 0.4 Ma, encephalization quotients for late *Homo erectus*, *Homo antecessor* and *Homo heidelbergensis* point to community sizes of 100-120 individuals. After 400ka encephalization indicates community sizes of 120-150 for both *H. neanderthalensis* and *H. sapiens* (Gamble *et al.* 2011). The constraint on group size imposed by the SBH can be used to infer a progression of group sizes that is broadly in agreement with the scheme advocated in Gamble's network approach (Grove and Dunbar 2015).

Such increases in community size favoured the development of speech, higher levels of intentionality as measured by theory of mind and cultural mechanisms that amplified the emotional content of social bonds, including music, dance and ceremony (Gamble 2009a; 2013). Neanderthals were capable of level four intentionality, with fifth order intentionality being the natural upper limit for the majority of extant modern humans (Gamble 2013; Gamble *et al. 2014*). Even normal modern humans find tasks of greater complexity than level four intentionality exceptionally hard to perform (Dunbar 1998) and the skills seen in the technologies of fourth order

intentionality reflect new abilities for coping with absence and separation, so social life continues, even in the afterlife (Gamble *et al.* 2014).

Raw material movement expanded considerably during the period between 300ka and 25ka, particularly in relation to *H. sapiens* after 60ka. There are precursors earlier than this – e.g. the presence of exotic raw materials from distances in excess of 200km (124.3mi) at the Middle Palaeolithic site of Champ Grand, France (Slimak and Giraud 2007) - but distances above 100km (62mi) remained exceptional until the European Upper Palaeolithic (Gamble *et al.* 2011) the majority of raw material being sourced within a two-day walking radius. While the 250km (155.3mi) that stone was transported to Champ Grand suggests an amplification of landscape use, the small quantities involved indicate the rarity of the procedure (Gamble 2013). In situations of high competition, a maintenance adaptation is expected, together with small dispersal distances and Neanderthals, as top carnivores, fit this model. Moreover, strontium isotope ratios from a Neanderthal tooth excavated at Lakonis, Greece, show a probable lifetime movement of only 20km or 12.4mi (Gamble 2009a). Neanderthal extinction may, therefore, rest in their evolutionary strategy that selected for a low-dispersal phenotype, characterised by a maintenance adaptation, a strategy that differentiated them from incoming *H. sapiens*. (Gamble 2009a).

Modern human societies are fission-fusion, multilevel, central place foragers, a combination unique among primates. Mediated by the increasing use of artefacts as symbols and the linking of ever more distant locales within a social landscape created by the establishment of habitual paths and tracks, a gradual extension of social life occurred throughout the Palaeolithic as local networks were incorporated into extended and ultimately global networks. The size of *H. sapiens*' social groups may have been only slightly larger than those of Neanderthals but the real difference lay in the fact that the connections and social responsibilities became much more complicated. Instead of being restricted to a local social world where you met most other members of your social network on a regular basis, modern humans could deal with prolonged separation. They also encountered social strangers on a more regular basis. Traded items symbolise trading partnerships and were a way of turning remote strangers into useful allies (Gamble *et al.* 2014).

While acknowledging that the social life of Neanderthal people was every bit as active and creative as that of modern humans, sharing their capacity for religion, myth and symbols, for Gamble (2013, table 5.10; Gamble *et al.* 2014) Neanderthal technology remained dominated by instruments and patterns of dispersal that characterized the population expansion of early humans at 500ka. This contrast to the display adaptation of *H. sapiens* marked a significant advance that released them from constricting bonds in face-to-face situations, freeing them from the foraging constraints of larger group size and low population density (Gamble 2009a; Grove *et al.* 2012). Neanderthal socio-ecology remained the primate pattern, driven by the reproductive costs of females and its asymmetry with that of males. Although versatile early humans, adapting to new niches as their populations expanded and with an increase in group fission-fusion and the beginnings of supra-community structures, they had not solved the art of living apart yet maintaining group cohesion (Dunbar and Grove 2015; Gamble 2013; 2018).

There is, however, European evidence (including the use of synthetically manufactured birch pitch for hafting composite tools) which collectively suggests that the major behavioural changes between MIS9 and MIS7 included new technologies, subsistence and land-use patterns (Chauhan *et al.* 2017). This indicates greater Neanderthal cognitive complexity and increased inter-group interaction across ever greater spatial and temporal scales (Wragg Sykes 2015).

The European record shows that Middle Pleistocene humans were present in a wide range of environments, including full glacial and colder steppic ones over large parts of Europe from about 500ka (Roebroeks 2006). British evidence suggests an important change in Neanderthal behaviour from the Early to the Late Middle Palaeolithic, with a much more sophisticated use of wider territories and the introduction of larger-scale seasonal movement in the Later Middle Palaeolithic. Whereas the Early Middle Palaeolithic evidence indicates permanent but short-lived occupation during temperate conditions on open mammoth steppe, in the Late Middle Palaeolithic this changed to seasonal occupation during summer, with over-wintering in mainland Europe. This would have extended hunting territories into otherwise uninhabitable regions, increasing group fission-fusion (Ashton and Scott 2016). Gamble (1987) argued that a

small home range could have supported local groups of 50-100 individuals through a 5-month winter provided they had access to frozen carcasses, located below the snow by using probes similar to, and possibly now mistaken for, spears. More recently, Hosfield (2016) explored the question of how early humans may have coped with the winter challenges of temperature and food availability in mid-latitude Europe. Examining the alternatives of annual migration over long distances versus shorter residential moves or local residency, he concluded that despite the acknowledged difficulties of resource availability, frostbite and hypothermia, lengthy annual migrations were unlikely. The faunal lists from a variety of Middle Pleistocene sites highlight a range of species that could, potentially, have been exploited by early humans during a Pleistocene winter (Hosfield 2016) with wild plant foods offering a further possible solution. Ultimately, Hosfield concluded that the benefits of reduced mobility within smaller foraging territories would have offered a variety of benefits in a winter landscape, reducing energy expenditure requirements and minimising the risk to more vulnerable group members. Consequently, while not straightforward, a winter residency model was more likely (Hosfield 2016) so long as the possibility of survival behaviours such as rudimentary cultural insulation, internal and possibly external food storage is accepted. However, it is likely that such overwintering strategies were not always successful (Hosfield 2016; MacDonald 2016). Although faunal evidence from Schöningen demonstrates that elements of Hosfield's winter residency model were in practice among Middle Pleistocene humans by at least 300ka (Hutson 2016) and there is indirect evidence for clothing from use-wear and residue analysis on lithic artefacts (Gilligan 2017), hard evidence for key material culture solutions, especially fire, is scarce in the European Lower Palaeolithic (MacDonald 2016) making it difficult to justify pushing the boundary back further than this, based on current evidence.

Neanderthal Local Operational Areas (LOAs)

The British Late Middle Palaeolithic (MIS3, ~59 -~36ka) has been largely regarded as 'the poor man of Europe' (White & Pettitt 2011, 25). Only two open air sites, Lynford, Norfolk and Little Paxton, Cambridgeshire, have so far yielded substantial Late Middle Palaeolithic assemblages, with only Lynford being excavated using modern techniques. All other open-air sites of the period are represented by very small assemblages or isolated

bifaces. The available absolute chronology suggests that MIS3 occupation was punctuated, with apparent foci of activity around the major river systems (Thames, Great Ouse, Little Ouse-Wissey and Solent) and the Chalk hinterlands of the North and South Downs (White & Pettitt 2011, 54). The relatively sparse Middle Palaeolithic archaeology from adjacent areas of the European continent indicates that Neanderthal occupation of Doggerland was likewise sporadic and perhaps restricted to interstadials. The Channel River system, with its network of linked streams, probably constituted a major barrier to northwards expansion by Neanderthals and Late Middle Palaeolithic settlement traces are consistent with the peripheral use of Britain by extremely mobile, small groups on a temporary basis, possibly during summer, with overwintering on the plains and hills of Doggerland (White and Pettitt 2011).

Arguing that such seasonal movements would have required a high degree of long-term logistical planning, enhanced levels of co-operation and finely tuned knowledge of the landscape and prey behaviour, White and Pettitt (2011; Pettitt & White 2012b) extended Gamble's Social Landscape concept into a model of Late Middle Palaeolithic (MIS3) Neanderthal 'Local Operational Areas' – local clusters of Middle Palaeolithic materials linked into an operational whole. These, they argued, were recognisable in the 'clusters' of Middle Palaeolithic bifaces seen in the Bournemouth (Dorset) area, in the Great Ouse valley around Fenstanton (Cambridgeshire), the Middle Thames valley around Hillingdon (London), the Sussex Downs and the Creswell Heritage area (Derbyshire). Other potential LOAs included Tor Bay, Devon (Kent's Cavern and Brixham Caves and their environs) and Coygan and Paviland Caves, Gower Peninsula, Wales (Pettitt and White 2012).

Using the Axe Valley, Somerset, as a case study area, White and Pettitt (2011) concluded that the Late Middle Palaeolithic archaeology of sites in the area (e.g. Hyaena Den, Rhinoceros Hole, Pickens Hole) shared sufficient common characteristics to link them together as a LOA, possibly forming part of a wider system of LOAs linked together by seasonal relocations. Taking the Creswell Crags, Derbyshire, World Heritage site, which has by far the densest concentration of Middle Palaeolithic occupation in Britain, as a second case study, Pettitt and White (2012b) concluded that it was the wider Cresswell landscape, not just Creswell

Crags *sensu stricto,* that formed a Neanderthal LOA. Although most British Late Middle Palaeolithic artefacts are made on locally available flint, non-flint materials were widely used in regions where they were more abundant than flint. In all the Cresswell caves, for example, 96-99% of artefacts were fashioned from locally sourced quartzite (White and Pettitt 2011). Small numbers of artefacts on clay ironstone and flint suggest wider material procurement, with a Cresswell LOA perhaps extending as far as Ravencliffe Cave, Derbyshire, ~40km to the west. This gives an indication of the scale of Neanderthal mobility in the region (White & Pettitt 2011), matching the 40km radius of Gamble's LHN.

Inevitably, given that only 2 MIS3 open-air sites are known to date, all of White and Pettitt's proposed LOA's involve cave sites lying outside the areas of southern Chalk Downland from which caves are absent and which have provided the bulk of the British Lower-Middle Palaeolithic record. Except in terms of possible occasional raw material sources, the evidence for LOAs therefore excludes landscape use patterns in areas away from the surroundings of caves.

It is very difficult to identify raw material transport patterns in the British Lower and Middle Palaeolithic owing to the high concentration of known sites in southern and eastern England and the ubiquity of Chalk-derived flint within these regions (Ashton 2008, 6). There is, however, no acknowledgement of the potential implications of the underlying geology and its consequent landforms in White and Pettitt's discussion of their model, raising the question of whether different mobility patterns might be seen in parts of Britain where cave occupation was not an option. The potential implications of differences in bedrock and superficial deposits are similarly unacknowledged. The use of raw material transport patterns in areas with different geologies (southwest France and east-midland Britain) to propose a universal model of early human ranging patterns will not necessarily be transferable directly to, for example, the Chalkland regions of Europe, where flint and flint gravel raw materials are ubiquitous.

Foulds (2016) analysed the lithic collections from the Axe Valley LOA as a pilot study for a project exploring the LOA hypothesis through in-depth analyses of White & Pettitt's (2011) proposed LOAs in the Axe Valley, the Gower Peninsula and Creswell Crags. The project, still in its early stages,

will address lithic, environmental and landscape data from existing sites in the three areas in the context of regional operational systems, with the ultimate objective of producing a wider synthesis of Neanderthal landscape use within the British Isles.

iii) Population Modelling

The two basic tasks of an archaeologist are to identify the spatio-temporal patterns of human presence and absence and to explain these patterns (Roebroeks 2006, 425). In northern France, a strong relationship can be demonstrated between the intensity of human occupation and the climatic and environmental context. This relationship appears to be conditioned by the relative abundance or scarcity of large mammal fauna, itself linked to vegetation density (Antoine *et al.* 2016). Many Old World population estimates fall within a range of 3,000,000-7,000,000 (Gautney & Holliday 2015) but estimating human population size during the Pleistocene is complex. Often based in part on archaeological site distribution, estimates are more a reflection of present-day geography than what the Earth was like in the past.

Gautney and Holliday (2015) calculated the habitable land area during the Last Glacial Maximum (22-19 ka) based on which they postulated a total Old World human population during that period of 2,117,000 – 2,955,000 based on medium-large bodied carnivore density, or 3,046,000 – 8,307,000 for hunter-gatherer densities. Also drawing on data for ethnographically observed hunter-gatherer population densities per km^2 and the surface area of the British Isles, Gamble (2002), estimated that total Pleistocene populations in England and Wales may have been between ~13,500 at high density and ~3000 if density was sparse. However, he acknowledged that these figures, which have been described as a massive overstatement by Pettitt & White (2012b) should be treated with caution. By comparison, Hosfield (1999,171) calculated a highly intermittent regional population of 350 individuals exploiting an area of ~50,000 km^2 in the Hampshire Basin during the Middle Pleistocene, a density of 0.007 individuals per km^2.

However, latitude has a very substantial effect on the area required to sustain a given group of individuals, expanding substantially as groups increase in size and move away from the equator (Grove *et al.* 2012). The impact of moving further from the equator can be seen in Table 3.1.

This has significant implications for calculations of group size and population density in northwest Europe, where human populations were, almost certainly, vanishingly small throughout the entire Pleistocene.

Table 3.1. Difference in group size sustainable in any given area as a result of distance from the equator.

Latitude	Group size
Equator	150
20º	113
40º	77
60º	41
80º	5

(Based on Grove *et al.* 2012, 194)

Primarily because Neanderthals were top carnivores, requiring a large territory per unit, their presence seems to have been characterised by a very low density and discontinuous occupation, with large swathes of Northern Europe possibly abandoned for >50% of the Middle Pleistocene, except in some limited refugial areas such as southwestern France, where continuous occupation can be demonstrated (Hublin and Roebroeks 2009; Pettitt and White 2012b; Roebroeks *et al.* 2011) and from which recolonization could take place. Most populations faced regional extinction, not southern exodus into refugia already occupied by core populations (Dennell *et* al. 2011; Hublin and Roebroeks 2009; Pettitt and White 2012b) and the possibility that Europe may have been uninhabited entirely during the maxima of some glacial periods cannot be excluded. Bocquet-Appel and Degioanni (2013) estimated a Neanderthal population of only 80 -1,300 individuals in the Perigord, France 45,000-40,000 years ago. For the combined territories of England, Wales, the Benelux, Germany, France, Spain, Portugal, Italy and the now submerged parts of Doggerland, Roebroeks *et al.* (2011) estimated a maximum Neanderthal population of 8,200 - 33,200. Even during favourable conditions and at the maximum extent of their range the total Neanderthal population consisted of, at most, 38,600-157,000 individuals, a figure greatly reduced during cold phases. In challenging climatic conditions European populations may have fallen as low as 1,500-2,500 individuals in southern refugia (Dennell *et al.* 2011). Even during the Upper Palaeolithic, figures as low as 4,400-5,900 (Confidence Interval 95% 1,700-37,700) have been estimated, rising to only

29,000 during the mid-Late Glacial recolonization (Bocquet *et al*. 2005). Like Neanderthals, modern human presence in northern environments can be characterised as highly discontinuous, with major parts of their northern ranges deserted around the Last Glacial Maximum (Hublin and Roebroeks 2009).

It is climate *variability* rather than climate *change* which is the driving force in human evolution (Grove 2011). Experience of environmental fluctuation within a given region equips organisms to survive future dispersals beyond that region, regardless of the mechanism by which this is achieved (Grove 2014). Periods of low climatic instability abruptly following extended periods of higher climatic instability are particularly favourable to dispersal (Grove 2014). Grove (2010) used the spatial distribution of sites and artefacts in the archaeological record to calculate early human group sizes, arguing that the relevant scale for attempts to reconstruct the territorial range over which a 'cognitive group' operated is neither sites nor continental surveys but clusters of sites clearly delimited by appropriate geography (spatial proximity), dating (chronological proximity), geology (stratigraphic proximity) and lithic typology. Using four well-documented datasets ranging from 1.75Ma to 14ka (Olduvai Gorge, Koobi Fora, Boxgrove and the Upper Magdalenian of the Paris Basin) his results broadly mirror the temporal trend predicted by Bocquet *et al*. (2005), of long-term Upper Palaeolithic demographic stability from the Aurignacian through the Gravettian and into the dramatic population increase during the LGM. Grove's results for all groups prior to the Upper Palaeolithic sit within or just above the level of Gamble's extended network (100-400 individuals), which itself encompasses 'Dunbar's Number' (Dunbar 1993) of 150 people comprising the modern human cognitive group.

The Deserted Britain model

Estimates of population decline in Britain based on artefact numbers have been described as 'virtually meaningless' (Pettitt and White 2012b, 281). Nevertheless, Ashton & Lewis (2002) attempted to overcome the problems of population modelling caused by variable preservation of artefact-bearing deposits, intensity of fieldwork and difficulty in interpreting the length of time represented by individual assemblages by examining fluvial terrace aggradations in part of a single river system (the Middle Thames). Using

data from the English Rivers Palaeolithic Project and taking into account time estimates for terrace aggradation, urban growth 1861-1927 (derived from historic OS mapping) and pre-mechanisation quarrying until 1932/35 (derived from the 1930s Land Utilisation Survey of Britain), artefact density within each terrace area was used to assess changes in artefact numbers over time. These were then used as a proxy for population density. The resultant pattern suggested a maximum peak in population density in MIS13 through to MIS10, followed by a decline into MIS8 and a sharp drop into MIS7, when the number of British sites is very low and often with small numbers of artefacts. The pattern continued, with a complete absence of British sites, until the MIS4/3 transition (Ashton & Lewis 2002; Wenban-Smith *et al.* 2010). The dearth of British sites attributable to MIS 6 to MIS 4 has been argued to be the result of a combination of changing human habitat preferences, climate and fluctuating sea levels (Ashton 2002; Ashton and Hosfield 2010; Ashton and Lewis 2002; Ashton *et al.* 2011; Ashton and Scott 2016; White 2015). It could, however, be the result of taphonomy, rather than true human absence – *i.e*. the lack, during that period, of a suitable sedimentary matrix being deposited to bury and preserve any traces of early human presence.

The generally accepted absence of humans from Britain during MIS5e at a time when they were clearly present on mainland Europe was challenged in 2006, during archaeological investigations related to the construction of the M25. Two artefacts were found in primary context in Pleistocene sediments on a spur of higher ground between the Darent Valley floodplain and a dry valley entering from the southeast. Optically stimulated luminescence dating (OSL) dated the artefact-bearing horizon to MIS5d-5b (Wenban-Smith *et al.* 2010). While this may indicate a glimpse of human presence in Britain shortly after MIS5e, its rarity indicates that even if humans were present during that interglacial, they must have been here in vanishingly small numbers (Ashton and Scott 2016; Lewis *et al.* 2011). Of 38 sites unequivocally dated by stratigraphy, geochronology and biostratigraphy to MIS5e as part of the Ancient Human Occupation of Britain project, none had evidence of human presence, whereas 14 of 28 sites dated to MIS7 contained associated archaeology (Lewis *et al.* 2011).

However, Britain largely lacks the MIS6 to MIS4 deposits that preserve human evidence in Europe, such as the extensive last glacial loess beds of

northern France, or the cave and rock-shelter fill sequences of Belgium. Although there are early Devensian, and older, loessic deposits in southeast England (Catt 1979; this thesis Chapter Five), they have received little attention and are generally undifferentiated in geological mapping of southern England from a generic and multi-genetic 'brickearth'. Continuing to ignore the implications of the absence of these sediments raises questions about interpretations of human presence or absence from Britain during the Devensian.

The model suggesting that Neanderthals progressively adapted to the mammoth-steppe of eastern Eurasia, only venturing into western Europe as these habitats expanded west (Ashton 2002; Ashton and Lewis 2002) can no longer be supported given the new evidence of Neanderthal presence in western Europe during fully forested, temperate conditions.– e.g. Caours, Somme(Antoine *et al.* 2006), Neumark-Nord, Lehringen and Stuttgart Germany (Roebroeks *et al.* 1992a). The number of northwest European sites during MIS 6 or 5e is, however, comparatively small compared to those dated to later MIS 5 or MIS 3, perhaps meaning that the region was on the fringe of Neanderthal distribution with too few groups to attempt to colonise Britain during MIS6 and 5e (Lewis *et al.* 2011).

The ‘Deserted Britain’ model has met with considerable opposition, particularly the assumption in Ashton’ and Lewis’ original (2002) study that a handaxe and a Levallois artefact had the same demographic significance Scott (2006). Others (White *et al*. 2006; Ashton *et al* 2011; Davis 2013; Pettitt & White 2012b) have pointed out the profound effect that increased curation of Levallois flakes and cores could have had upon patterns of artefact discard. Where heterogeneous raw material sources allow observations to be made, Levallois products are frequently made on non-local raw material, again suggesting a mobile curated technology (Geneste 1985 cited by White *et al.* 2006). White *et al.* (2006) also questioned the use of artefact density as evidence of dramatic depopulation in MIS7, pointing out that if site numbers, rather than artefact density, were used, humans were equally well represented in Britain throughout MIS7. They nevertheless concluded that a regional population crash during early MIS6 was ‘a pretty inescapable conclusion’ (White *et al.* 2006, 538).

A further criticism has been that changing artefact and landscape use from the Lower to the Middle Palaeolithic would have affected the quantity and distribution of artefact discard locations (Scott 2011; White *et al.* 2006). Whereas Lower Palaeolithic occupation favoured river valleys, the encroachment of the mammoth steppe into western Europe during MIS8 enabled a broader use of landscape, in particular of areas more distant from rivers (Gamble and Roebroeks 1999; Guthrie 1990; Scott *et al.* 2011). This, combined with larger territories and a more curated toolkit resulted in a more dispersed discard pattern. However, while there is some evidence of this in northern France during the Early Middle Palaeolithic, this interpretation is not supported by the British evidence (Ashton *et al.* 2016), perhaps owing to the scarcity of sites.

Despite acknowledging that the close of MIS7 does appear to have seen a total population collapse (Pettitt & White 2012b, 284) Pettitt & White also argued that the meaning and validity of the patterns proposed by the 'Deserted Britain' model were open to question. Other factors cited as potentially affecting artefact density included the relationship between group size and the number of handaxes manufactured, the effect of variable resources in the landscape and the use of terrace area, rather than terrace volume, as a means of calculating artefact density. The validity of this latter point was acknowledged in Ashton & Hosfield's later (2010) study of population density in the Hampshire Basin. Regional differences in the archaeology might also be a factor affecting the results, given that the pattern of artefact decline seen in the Middle Thames Valley was not mirrored in the Solent data when Ashton' & Lewis' methodology was replicated based on handaxe data alone Hosfield (2005).

The Solent Basin was one of the most favoured places for Lower Palaeolithic human occupation in Britain (Wymer 1999). To test the validity of the Middle Thames data and address the questions of human arrival, technological and population changes, Ashton and Hosfield (2010) looked again at the archaeological record of the Hampshire Basin rivers, including the former Solent river and its principal tributaries, the Frome, Stour, Avon and Test. Because of the dearth of Levallois material from the area, Ashton and Hosfield focussed their analysis solely on handaxes and although the results from the Solent area were less clear, a similar pattern of population trends was identified up to MIS8, lending some support to the data from the

Middle Thames. Both regions indicated relatively larger populations in the latter part of the Lower Palaeolithic, ca. 500ka to150ka (Ashton & Hosfield 2010), with peak populations during MIS13 to MIS10 and apparent falls in population from MIS9.

Hosfield (2005) suggested that particular demographic conditions may have encouraged the lasting adoption of innovative technological practices. Using artefacts from separate terrace formations of the Solent as a proxy for population size, he suggested that early human populations in the region were small during MIS13 and MIS11, but increased significantly during MIS9 – the period within which Levallois emerges. This elevated population may have resulted in larger group size, providing the social framework necessary for the lasting adoption and transmission of this technological innovation. Hosfield's model permits the possibility of numerous Levallois-type technological innovations prior to MIS9, which were unsuccessful and short-lived because of inefficient transmission mechanisms within small populations. Scott (2006) however, questioned whether elevated population numbers would necessarily have led to larger group size.

Ashton *et al.* (2011) revisited Ashton' and Lewis' earlier Middle Thames study, excluding Levallois artefacts and restricting their analysis to the three highest terraces, the Black Park, Boyn Hill and Lynch Hill gravels, thereby avoiding any potentially problematic comparisons between Lower and Middle Palaeolithic artefacts. They also ran two additional analyses to investigate the effects of 'super sites', defined as assemblages contributing >10% of those in a study area (Ashton and Hosfield 2010) on the results. Although acknowledging the difficulties of comparing the Middle Thames and Solent data, they were satisfied that, in all cases, results from both areas showed a decline in hand-axe density between MIS 11 and MIS8, supporting the conclusions of their original (2002) study.

Davis (2013) re-calculated Ashton and Hosfield's (2010) hand-axe densities from the Bournemouth and Test terraces using updated terrace assemblages and terrace volume instead of area. Artefact recovery dates were also taken into account to refine their quarrying and urbanisation data. After allowing for the effects of potential collector bias, vertical reworking of artefacts and the impact of 'super sites', Davis' analysis revealed a pattern

of decreasing hand-axe density through time in the Bournemouth and Test terraces, parallelling the Middle Thames data and strengthening the patterns previously identified by Ashton and Lewis (2002), Ashton and Hosfield (2010) and Ashton *et al*. (2011). He concluded that this pattern of declining hand-axe density could not be explained by recovery biases or formation processes alone so was likely to reflect the realities of past human occupation in the Solent region (Davis 2013, 165). At present, the declining population model stands alone in explaining this pattern.

There are two possible explanations for the decline in handaxe numbers: firstly, that it represents a fall in population size; or, secondly, that declining artefact numbers reflect a change in behaviour that resulted in fewer handaxes being discarded on river floodplains (Davis 2014). The increase in human mobility and broader landscape use apparent in the Early Middle Palaeolithic (White et al. 2006) may well have originated in the Lower Palaeolithic, which could explain the pattern of decreasing handaxe densities in the river valleys (Davis 2013), as would a change in the procurement and transport of raw materials, and the curation of artefacts. However, there is also evidence contradicting this, as well as many similarities in habitat preference, raw material procurement, artefact curation and technology between MIS 11 and MIS 9 assemblages which suggest that a major behavioural change is unlikely (Davis 2013).

iv) Colonisation patterns

A regional archaeological model concerned with the human colonisation of Britain and Northern Europe during the Middle Pleistocene must take into account two crucial questions – how were sites in the archaeological record formed; and what is the behavioural significance of the discarded material (Hosfield 1999,111)? The key drivers in the Lower and Middle Palaeolithic colonisation of Britain from the European continent were its changing palaeogeography and climate (*cf.*Chapter Five). In considering these, archaeologists have focussed principally on changing access routes and population sources, as visible in technological changes in the archaeological record.

A number of MIS11 sites in Britain display a change in lithic technology during the interglacial, from simple core and flake working non-handaxe assemblages to those with handaxes. Based on recent work at Barnham,

Suffolk, Ashton *et al.* (2016) have argued that this sudden introduction of handaxe technology reflects the behaviour of distinct human populations from different source areas in Europe. As most handaxe sites tend to be in the west and south-west of Europe the first colonizers of Britain during MIS11 perhaps came from central Europe without handaxe technology, while the second group arrived from western Europe at the end of MIS11 Hoxnian substage Ho II (Ashton *et al.* 2016).

Using data drawn from the British Museum's collection of over 80,000 British Lower and Middle Palaeolithic artefacts, Ashton *et al.* (2015) examined the changing geographical distribution of handaxe and Levallois locations in Britain throughout the Middle Pleistocene. Sites in south-east England dominate the record, with little data from other areas. Taking account of collector bias and differential access to geological deposits and with the 'super-site' effect avoided by the use of sites, not artefact numbers, a clear pattern emerged. The vast majority (92%) of Levallois locations are in the lower reaches of eastern rivers, especially the Thames, with a dearth in southern, Midland and western river systems (Ashton *et al.* 2015). This suggests that populations bearing Levallois technology entered Britain from the east across the southern North Sea area.

The Solent region has a remarkably small Levallois record by comparison with both its rich handaxe record and with the Levallois of the Thames Valley (Davis *et al.* 2016). For Ashton and Hosfield (2010) the explanation lay in the changing palaeogeography of Britain, which saw a gradual subsidence of the North Sea basin from a high stand of 0 metres OD during MIS11 to - 40m OD today (Ashton *et al*. 2011). Easterly routes into Britain were dependent on the geography of the North Sea Basin, while routes from the south were dependant on the width of the English Channel or, in cooler periods, the Channel River. By MIS8 and MIS7, based on current topography, substantially different drops in sea-level would have been required in the English Channel (>60m), the Dover Strait (>30m) or the North Sea (~20m) to significantly reduce the sea barriers in these areas. These contrasting geographies may have resulted in colonisations during different climatic and environmental phases in the two regions (Ashton & Hosfield 2010). For Pettitt and White (2012b), however, such sea-level projections rely on *a priori* conclusions rather than empirical figures.

White *et al.'*s (2006) study of British Early Middle Palaeolithic (MIS9 to MIS7) sites also considered the potential for using lithic artefacts in the reconstruction of early Neanderthal behaviour, settlement and technological organisation. Although few of the sites had been carefully excavated or provided high resolution data, coarser-scale patterning in the record again suggests the distribution of hand-axe sites was in the west, with Levallois most strongly represented in East Anglia and the Thames Valley.

There is also evidence for regional differences in early Middle Palaeolithic archaeological signatures on mainland northwest Europe, with Levallois-dominated industries being found in northern France, Belgium and the Netherlands and handaxe assemblages found south of the Seine. Scott and Ashton (2011) compared the best dated and contextualised early Middle Palaeolithic British and northwest European sites, highlighting a similar east-west divide in both areas, a finding confirmed by Chauhan *et al.* (2017). Although the vast majority of sites reviewed reflected a dominance of Levallois flaking, the two best-dated early Middle Palaeolithic sites with evidence of handaxe manufacture and transport, Ranville and La Cotte de Ste. Brelade, lie towards the western side of the study area (Scott *et al* 2010; Scott & Ashton 2011). The conclusion, again, was that the British pattern may reflect different source areas for populations in Britain. The matching east-west patterns in Britain and on the Continent perhaps relate to colonisation routes, with humans passing along river valleys from the west of France into the Channel region and on to the Solent, while the Thames pattern relates to humans travelling across the North Sea from rivers further north Ashton *et al.* (2011).

Possible alternative explanations for the difference between the Solent region and the Thames Valley have included that the Solent Levallois record reflects preservation and recovery bias; that the scarcity of Levallois is representative of low density occupation during the Early Middle Palaeolithic; or that human populations in the Solent continued to use a technology focused on hand-axe manufacture (Davis *et al.* 2016). However, Levallois artefacts from the MIS8 Lower Warsash Terrace at Warsash, Hampshire, may be contemporary with the main phase of Levallois technology in the Thames and are likely to represent a limited dispersal of Neanderthal populations further into Britain from their entry route across the North Sea Basin (Davis *et al.* 2016).

Scott *et al*. (2011) re-examined several Middle Palaeolithic assemblages from the Thames Valley studied previously by White *et al* (2006), based on which they argued that Levallois flaking was dominant in the Lower and Middle Thames, where flint was readily available, while hand-axes were still produced in other areas further west - eg.at Dix's Pit, Stanton Harcourt (Upper Thames Valley). Based on comparisons with Harnham (Wiltshire) and Broom (Axe Valley Somerset) they also concluded there was an east/west technological divide and that these different technological approaches could reflect the socially transmitted practices of particular early human groups (Scott *et al.* 2011). However, Harnham is the youngest well-dated example of an Acheulean industry in the UK and one of the youngest in Europe. Also based on evidence from there, Bates *et al*. (2014) offered the alternative explanation that the MIS8 southwestern evidence from sites such as Harnham, Broom and Cuxton (Medway Valley) instead represented the persistence of a UK hand-axe dominated adaptation from MIS9 through to the late MIS8 interstadial, followed by local extinction of the British population. This was followed by colonisation by a population with Levalloisian technology from northwest Europe (Bates *et al*. 2014).

v) Landscape Use

The Riparian Preference model

Cohen *et al.* (2012) suggested that the early (pre-MIS12) Palaeolithic evidence from Atlantic north-west Europe indicates that early humans might have had a preference for coastal plains and the connected lower parts of river valleys during times of interglacial climate, their 'coastal Atlantic dispersal' hypothesis. This proposed that the coastal climatic zone provided a dispersal 'corridor' or 'filter route' for northward dispersal of early human populations from southern Europe. Thanks to reflection of the sun's rays, the favourable microclimate of slopes in river valleys on Chalk bedrock, such as the Arun, Ouse, Rother, Medway and Kentish Stour, would have offered an appealing inland dispersal route (Cohen *et al.* 2012). More than 90% of Lower and Middle Palaeolithic finds and sites in Britain and along the north European seaboard come from river gravel deposits (Pettitt & White 2012b,138; Brown *et.al* 2013) hardly surprising given the intense commercial exploitation of the gravel terraces associated with fluvial systems in the last 200 years (Wilkinson 2001). Nevertheless, most British

Lower-Middle Palaeolithic evidence does come from river valleys, leading Ashton *et al.* (2006) to propose a 'riparian preference' model of early human occupation. Using evidence from archaeological and geological sites dating to MIS11, they argued that the dominance of human activity in riparian habitats was a true reflection of human habitat preference. Owing to lack of evidence from other locales, they considered only river-valley and lake-edge sites in formulating their model. The evidence for significant human activity on the interfluves, from dolines and surface scatters, was excluded because it could not be dated or correlated with other sites, although the inevitable bias this introduced was freely acknowledged. Seven MIS11 sites with both archaeological assemblages and lacustrine sediments were reanalysed, including Barnham, Elveden (Ashton *et al.* 2005), Beeches Pit, Hoxne and Foxhall Road (all Suffolk), Hitchin (Hertfordshire) and Marks Tey (Essex). Four of these – Barnham, Elveden, Hoxne and Hitchin – were identified as having been occupied only after the lake basin had infilled and a fluvial drainage network had become established. Seventeen non-archaeological MIS11 lacustrine sites were also examined, four of which were identified as places where artefacts should have been recovered if present, since all were active quarries in the 19th century and had a history of local collector activity. The lack of archaeology at those sites means that none of the MIS11 sites that have been extensively researched or where there has been active collection has provided unequivocal evidence of human activity linked to local lacustrine habitats. Based on their analyses and in the absence of any evidence to the contrary, Ashton *et al*. (2006) concluded that, during fully temperate conditions, humans preferentially targeted fluvial environments because, thanks to the destructive effects of large herbivores, they were more open than lake margin environments, with a greater range of fully open to more forested habitats. They argued that river valleys would also have provided a wider range of resources, with a higher biomass of grazing herbivores than on the wooded interfluves, while floodplains provided a mosaic of habitats offering a wide range of animal and plant resources and easy access to stone raw material. (Ashton *et al.* 2006). In contrast, in the absence of fluvial erosion, flint on the interfluves was probably only accessible in cool or cold conditions, through subaerial weathering of underlying Clay-with-flints or solifluction. During more open, cooler conditions, however, the interfluves would have been used because access and navigation would

have been easier in their more open landscapes and a new range of resources would have become available (Ashton *et al.* 2006).

This argument ignores the fact that flint-bearing Chalk bedrock outcrops extensively across the plateaux, varying in thickness between ~200 and 560m (Aldiss *et al.* 2015). This would have made it accessible to early humans at least sometimes, as evidenced at the Caddington cottages site, where numbers of large, partially flaked block of flints were found, some having been artificially quartered in Palaeolithic times (Smith 1894, 114, 154). The model also fails to take into account that major rivers would have been difficult to cross, dangerous when in flood, often cluttered with vegetation and faunal debris or harbouring unhealthy swamps. Rather than uniting occupants along a supposed routeway, they could have divided peoples from bank to bank and given that, throughout the Middle Pleistocene, streams would have been abundant in the landscape, rivers would not always or necessarily have been the focal point for game (Hardaker 2004). In addition, the model does not consider the potential impact on the archaeological record of the release of artefacts into river valleys by extensive river gravel extraction, nor the effects of periglacial processes such as solifluction and soil slumping which, during later glaciations, would have carried some plateau archaeology in Head deposits down into the river valleys (*cf.* Chapter Nine) as happened with the Wallingford Fan Gravels in the Thames Valley. Even the refitting artefacts from the unit 11 Head gravel at Boxgrove may have been moved *en masse* from interglacial deposits on the plateau above (White 2015, 166). The river valley concentrations could be partly the result of preservation and collection opportunities, with artefacts being rapidly buried in river sediments and then accidentally discovered by modern humans in quarries and pits (Pettitt & White 2012b, 133). The potential impact of both periglacial processes and of the aggregates extraction and infrastructure-building industries on archaeological distribution patterns are issues I explore in Chapters Five and Six of this thesis.

It has been argued (Wymer 1999,41) that there was an equal density of population elsewhere at times, and that the preponderance of palaeoliths in river terrace deposits simply reflects that this was where they found raw material along the river banks, made tools and then discarded them. It is also worth noting that the fully temperate conditions during which river

valleys are claimed to have been used preferentially, existed for only about 8% of the Middle Pleistocene, with intermediate conditions between extreme glacials and extreme interglacials like MIS11 accounting for about 60% of the last 440,000 years (Gamble 1995b). Springs and ponded dolines on the interfluves would have provided water for humans and game, probably including large herds of desirable large herbivores such as mammoth, rhino, horse and deer (Wenban-Smith *et al.* 2010), meaning the interfluves were not as barren of resources as the 'riparian preference' model suggests.

The Nutritional Niche' model

Wymer (1999, 46) argued that not just river valleys but the confluences of main rivers and their major tributaries were preferentially used by early humans, because they provided junctions between routeways and gave access to resource-rich plains and to different parts of the landscape, such as the Chalk hinterland. Brown *et al*. (2013) took a 'nutritional niche' approach to test their hypothesis that the marked concentration of the richest, pre-MIS5 sites (i.e. those with >500 bifaces) in the lower reaches of river-valleys, mostly upstream of but close to estimated interglacial tidal limits, was a real archaeological distribution and not taphonomic in origin.

Based on data from 23 Pleistocene archaeological sites in the Channel region of Britain and northwest France, plus faunal and floral evidence from 37 British and northwest European palaeoecological sites, they created a plant and animal database to estimate the potentially available macronutrients (proteins, carbohydrates and fats) and micronutrients available along a landscape transect (the' nutriscape'). This they divided into seven zones, from valley-bottom to plateau top, with the floodplain further divided into river channels (including gravel islands and banks) and the remainder, which included river terraces. The plant and animal lists were then used to calculate the approximate balance of energy (kcals), protein and carbohydrates+fats (CF) as a percentage of the total values for the entire landscape (all seven zones). Brown *et al*. (2013, 11) concluded that, taken together, the overall nutritional diversity and availablility of key micronutrients made the floodplains the optimal location through easy access to food resources of all types and that early humans at the edge of their geographical range located themselves in nutritionally optimal

locations. The distribution of the richest Lower to Middle Palaeolithic sites in this part of northwestern Europe was, therefore, a real behavioural distribution, reflecting human activity patterns rather than a taphonomic distribution and supporting the contention that river valleys provided nutrient-rich route-ways of exploration and landscape utilisation.

Brown *et al.*'s conclusions are open to criticism on a number of fronts. First, they ignore the fact that the 'super site' phenomenon can be explained, at least in part, by geomorphological processes. Two rivers coming together could have generated a local decrease in water velocity, resulting in deposition of the river's load, including artefacts transported from different source areas (Hosfield 1999). Rivers through Chalk have steeper gradients, with steeper-sided valleys and few surviving terrace gravels. The gravels from such rivers were offloaded once the Tertiary bedrock, with its shallower river gradients, was reached, resulting in an abundance of fluvial gravels at and below the junction (Hosfield 1999; Ashton and Hosfield 2010). These provided not only attractive raw material sources for early humans but also a rich source for modern aggregate extraction and antiquarian collectors. Of six 'super-sites' identified in the Solent catchment (Ashton and Hosfield 2010), four lie at the Chalk/Tertiary boundary. The gravels probably also contain a large reworked element from earlier terraces on the Chalk Downs (*cf.*Chapter Five).

Second, their English data was drawn from The English Rivers and Southern Rivers Palaeolithic Project reports, although only that from single quarries and gravel pits, or adjacent quarries. There was no acknowledgement of the admitted confusion (Wessex Archaeology 1993, 91) about the recorded provenances and names of various of the brickearth pits -e.g. in the Crayford area. They argued that, because of the large numbers of collectors, with their preference for bifaces and the large number of quarries, operated principally for railway ballast and road construction, it is very unlikely that rich sites were missed (Brown *et al.* 2013). This, however, assumes that all human occupation was in areas with commercially attractive aggregates, that collectors were equally active in every aggregate extraction area and that the preservational and release qualities of all geologies is equal. My results demonstrate that this was not the case (*cf.* Chapter Nine). A species may be absent from a suitable site or present in an unsuitable site for several reasons, such as incomplete or

selective sampling, while the probability of erroneously not recording presence is often greater in unsuitable sites than in suitable sites (Hirzel & Le Lay 2008, 1372). Brown *et al.*'s assumption that the nutritional requirements of Middle Pleistocene humans were related to both their phenotype and their environment in a way which is comparable to modern humans, and that energy expenditure patterns were not unlike those seen today, ignores the evidence from recent bioenergetics studies. These demonstrate (Churchill 2006; Froehle & Churchill 2009; Sorenson & Leonard 2001; Sorenson 2009; Snodgrass and Leonard 2009) that Neanderthals had an absolutely greater average body mass and amount of surface area than modern humans– even arctic-adapted ones of similar stature – resulting in substantially higher energy needs than anatomically modern humans in similar climates. While it may be highly likely that river valleys were central to early human landscape use, no attempt was made by Brown *et al.* (2013) to assess the basis of the site distribution patterns on which their model was predicated. In this, they ignored not only the differing preservation and release opportunities presented by different geological deposits but also the wider range of geomorphological processes that have impacted on the landscape during and since the Pleistocene.

The Routed Foraging model

It was Lewis Binford who, in 1984, first introduced into archaeology the concept of routed foraging in which the location of repeatedly used locales, resulting in a natural build-up of cultural material, was directly determined by the local ecology. This included lithic outcrops, waterholes and naturally defended or sheltered places. Hosfield (1999) advocated a multi-scale methodology integrating both excavated and surface data to provide a holistic dataset. The primary goal of Hosfield's spatial modelling was, using GIS, to produce a model of the spatial variables (both mobile and static) in the opportunities for archaeological discovery, in an attempt to answer the question of how the archaeological potential of a landscape can be estimated when there has been little or no excavation. The spatial distribution of accumulated lithic archaeology 500ka to 128ka in the Hampshire Basin demonstrated favoured exploitation by early humans of selected drainage systems and river valleys. Within spatially limited (predicted as 3418.66km^2) home ranges, early humans moved between

highly localised foci of activity, revisiting and exploiting these intermittently over single climatic phases (Hosfield 1998). 'Tethered' to these favourable local areas within riverine landscapes, their repeated foraging could include migration routes for herbivores, grazing territories and natural features (water-holes, river crossings etc.) which would have attracted fauna and accumulated carcasses. This was 'routed foraging', rather than 'central place'-based activity, a model of localised behaviour set against the environmental background of a vastly under-exploited and challenging landscape (Hosfield 1999).

Hosfield (1998) identified six variables that can influence the discovery of Palaeolithic materials. These include Pleistocene geology, local antiquarian activities, the aggregates extraction and infrastructure industries and periglacial processes such as erosion. These he factored into his modelling, strengthening it significantly as a result. My research explores the impact of these variables on the archaeological record of the Chalk uplands.

Persistent Places

The term 'persistent place' was first used by Schlanger (1992) to describe localities with evidence for repeated use during long-term regional occupation and was later used to describe such places during the early Holocene (Barton *et al.*1995) and by modern hunter-gatherers (Schlanger 1992; Zedeño 2008).

Schlanger (1992) identified three key requirements for a location to become a persistent place. These are - unique qualities particularly suited to certain activities/behaviours; natural features that focus reoccupations; and accumulations on the landscape of cultural material resulting from extended occupation or revisitation. Long term persistence enables the identification and recognition of changes in how early humans structured their use of place and landscape.

Persistent use of place emerged gradually during the Middle Pleistocene and was a culmination of normal, gradual evolution (Foley 2016). Demonstrating their appearance within a region is a key, but unresolved issue in Palaeolithic archaeology (Pope 2018). Between 800ka and 200ka, early humans redefined their relationship with the land they lived in by creating special places, 'super-sites' in the sense of superimposed levels of

occupation, often spanning more than a single MIS – e.g. La Cotte de St Brelade, Jersey, Boxgrove, Sussex, La Ferrassie, Dordogne and Menez-Dregan I, Plouhinec, Finistère. The repeated use of such sites indicates environmental knowledge based on individual and group long-term memories, while as cultural places they also indicate the emergence of the concept of accumulated time (Gamble 2013). A minimum requirement for a Lower-Middle Palaeolithic persistent place is that its occupation spans at least one glacial/interglacial cycle, a time frame requiring acknowledgement of how landscapes change in response to geological, ecological and cultural factors (Gamble 2018; Pope 2018; Shaw *et al.* 2016).

The appearance of persistent places during the Middle Pleistocene can be taken as an index for human familiarity with and enculturation of landscapes, demonstrating that early human niche construction was both culturally constituted and ecologically informed (Scott and Shaw 2018; Shaw *et al.* 2016). To illustrate this, Shaw *et al*. (2016) drew on recent work at the site of La Cotte de St Brelade, Jersey (Bates *et al*.2013; Pope *et al.* 2015b; Scott *et al.* 2014), where evidence from the deep Middle Pleistocene deposits shows a semi-continuous Neanderthal presence from at least 240ka until after 40ka. La Cotte was a stable place within a changing landscape, an *intended* destination (my emphasis), not just somewhere encountered by chance through undirected wandering (Scott and Shaw 2018). People returned there repeatedly, bringing their tools with them, throughout temperate, cooling and cool conditions and despite dramatic shifts in local environment, offshore topography and regional geography (Scott and Shaw 2018; Shaw *et al.* 2016). How the site was used and the material brought to it changed over time, with evidence for short-term occupation and use of an expedient tool kit during MIS 7, but longer-term occupation and use of local raw materials in MIS6.

All landscapes have profound significance and meaning for persons and groups (Tilley 2008, 274). While not calling them ‘persistent places’, Brown *et al.* (2013) argued that early humans did more than simply locate themselves in nutritionally optimal places, altering them through repeated and/or prolonged visits. For Shaw *et al.* (2016), La Cotte was a persistent place not just because it offered shelter, wide views over the surrounding plains and its headland was widely visible to travellers, but because people invested it with importance by travelling there again and again over

hundreds of generations. By persisting both mentally and physically, persistent places provide an insight into early Neanderthal ‘landscapes of mind’: places distant in time and space but representing destinations around which life was organised (Shaw *et al.* 2016).

Glauberman’s (2016) analysis of nine surface scatters and eight excavated sites in Belgian Limburg demonstrates that persistent places were not confined to river valleys and floodplains and that palimpsest lithic surface assemblages and some Middle Palaeolithic plateau localities were also persistent places, or at the very least landscapes of habit (see below) frequently re-occupied for a variety of purposes.

A potential objection to the concept of Palaeolithic persistent places is that they were simply long-lived capture points for Pleistocene sediments in which archaeology could be preserved, a geomorphological possibility not addressed by Shaw *et al.*(2016) or other advocates of the model. Alternatively, they have been seen as places visited repeatedly because of their visibility from a long way off. Purfleet, in the Thames Valley, for example, was a persistent place only because its location in a large main loop of the river Thames aided rediscovery by successive human groups. It was also a place with natural features and rich resources which would have encouraged reoccupation (White and Bridgland 2018).

Ashton (2018) explored the complementary idea of ‘landscapes of habit’, rather than ‘persistent places’. For him, it was the stability of place itself and of the broader environment which generated and sustained persistence of behaviour. During the Middle Pleistocene in Europe, landscapes of habit were created during stable conditions and localised culture developed alongside strategies for living in particular habitats with the resources they provided. It was adaptation to local circumstances that created habits of behaviour which became embedded in cultural practice. For Ashton, the concept of a persistent place was different, one in which the enculturation of places as a result of previous use was a critical ingredient, something which is extremely difficult to demonstrate conclusively in the Middle Pleistocene archaeological record. For Ashton, La Cotte and other primary context sites such as Cagny la Garenne and Grande Vallée (France), Barnham, Swanscombe and Boxgrove (England) were not demonstrably true persistent places, their repeated occupation the result of

intergenerational traditions of inherited knowledge. Rather they were landscapes of habit, primarily determined by their location in their landscape and the distribution and variety of resources they offered. Persistence of place during the Middle Pleistocene was dependent on environmental stability, sometimes provided by more permanent and protective features of the landscape. The question of when landscapes of habit became persistent places despite shifts in environment, allowing for longer-term encultured landscapes, remains open (Ashton 2018).

The Static and Mobile Resource model

To explain artefact discard patterns at the Lower Palaeolithic site at East Farm, Barnham, Suffolk, and the occurrence of biface and non-biface assemblages being made in the same environment, Ashton (1998) proposed a 'static and mobile resource' model as an alternative to traditional cultural and technological models. The model depends on the presence of a variety of attributes, including the type and permanence of resource location, differences in assemblage composition and changes in artefact density.

The key landscape elements identified at Barnham were a small stream or river, with an occasionally exposed lag gravel (the cobble layer) on its southern margin providing a natural source of raw material from which many artefacts were made. From faunal and floral evidence it was clear that the river also provided a rich and diverse range of animal and plant life.

Differences in artefact discard patterns in the different areas at Barnham created 'scatters' and 'patches' (Isaac 1981) of artefacts. While recognizing that scatters were likely to overprint patches and become archaeologically indistinguishable, the resultant 'veil of stones' (Roebroeks *et.al* 1992b) led Ashton (2004) to suggest that such variations might reflect the different effects of the presence of static or mobile resources. Static resources, such as the Barnham cobble bed, would lead to a series of repeated actions in one location and a concentration of artefacts; mobile resources, such as animals providing kill or scavenging opportunities, would lead to a series of single event discards over much wider areas. The degree of permanence of the resource would have directly affected the amount of discard in any one location (Ashton 2004), the repeated transport of lithic resources to other fixed resources (water, vegetation, sleeping places, wood and other raw

materials) causing both the accidental and the deliberate accumulation of lithic material (Ashton 1998). In this, Barnham was a 'habitual' place (*sensu* Ashton 2018), rather than a 'persistent place'.

The relatively constant nature of the landscape at Barnham, where activity can, in some instances, be measured in centuries or less (Ashton 1998), overcomes many of the criticisms made of the use of such models over the long time-frames of East Africa, where they were first proposed. The model also makes sense of the data from Boxgrove, with biface-rich locales close to the cliff offering access to fixed resources (raw materials, fresh water, plant foods and game aggregations) and biface-poor locales away from the cliff representing grassland that supported exploitation of mobile game resources (Pope 2002; Pope 2004). However, as Ashton himself acknowledged (1998) although one of the strengths of this model is the recognition it gives to the mobility of flint and the complexity of human behaviour, its viability to provide solid explanations depends on the degree of archaeological and environmental resolution available. Patterning in artefact transport and discard should, perhaps, be viewed alongside the colonisation of northern latitudes, hunting and increased raw material transport distances, as forming part of a suite of behavioural developments during the Middle Pleistocene (Pope 2004).

vi) Patterns of upland and lowland living

The Chalk uplands clearly had specific attraction for early humans (Roe 1996, 4) and, despite a continuing focus on lowland fluvial contexts, increasing interest in the upland archaeological record (Beresford 2014; Glaubermann 2006; 2016; Groendijk and de Warrimont 1995; 2007; Halliwell and Parfitt 1993; Harp 2005; Pope *et al* 2015a; Scott-Jackson 2000) has generated debate about potential behavioural differences between the upland and lowland areas of the landscape (Drinkall 2013; Kolen *et al*.1999; Tuffreau *et al*. 1997; White *et al*. 2006).

Middle Palaeolithic assemblages are 'binary' in nature, with a clear distinction between locally produced 'expedient' components and transported and curated tools (Blezer *et al.* 1996). Sites in France (Duchadeau-Kervazo 1986; Kolen *et al.* 1999; Raynal *et al.* 2013; Tuffreau *et al.* 1997; Vallin and Masson, 2004;) and the southern Limburg plateau (Kolen *et al.* 1999; Roebroeks *et al.*1987; Roebroeks *et al.* 1997) have

revealed clear patterns between sites in terms of assemblage size, raw material proximity and the particular technological acts undertaken at individual sites. Roebroeks *et.al* (1992b) suggested that the high-density patches (sites) might have been the places where technology was maintained, whereas the low density 'background' scatters were mainly where technology was used, for example in subsistence activities. The marked differences between technological practices in the uplands and those at sites in the valley bottom have been interpreted as representing spatial differentiation of activities between the valley bottom and the plateaux, though this is a matter of 'relative weight' of activities, rather than exclusivity (Kolen *et al.*1999). Early humans predominantly collected flint in outcrops along the plateaux edges and valley slopes, where they subsequently prepared cores and tools - at sites like Creffield Road, West London (White *et al.* 2006) - for activities to be carried out in the valley bottoms. After short visits to the valley for subsistence activities they generally returned cores, flakes and tools to the plateaux edges, where they were eventually discarded and replaced by new items.

Behavioural differences identified in different parts of the Thames catchment likewise seem to reflect curation tactics in response to raw material availability. In addition, the Lower Thames valley bottom sites reflect a much more restricted range of activities than terrace surface sites in the Middle Thames, which may have been located on higher ground, potentially with commanding views of their surroundings (Scott *et al.* 2011). This logistical separation between sites where early humans provisioned themselves on the higher ground and sites in the valley to which they transported material, including Levallois products, has become widely accepted as a classic facet of Middle Palaeolithic behaviour (Scott 2006, 305).

The majority of Middle Palaeolithic locations in the higher landscape of Southern Limburg are situated along the valleys of the River Geul and its smaller tributaries in the north and east of the region, in the Maas Valley and on the northern valley slopes of the River Voer. These high ground surface scatters are located predominantly along the edges of plateaux, often near the confluence of river valleys or on conspicuous promontories and all with wide views over the surrounding landscape. This has been interpreted as a topographical preference for predominantly south- and

west-facing escarpments and valley slopes, which would have offered favourable conditions for settlement, being warmer, lighter and drier than other landscape sectors and sheltered from cold easterly and northerly winds. Their sweeping vistas would have allowed monitoring of animal movements and the availability of animal carcasses in nearby valleys. (Kolen et al. 1999). Similar patterns have been reported for other regions and wide vistas over the river valleys seem to have been a crucial factor in early human location choice (Drinkall 2013; Kolen *et al.* 1999; Scott-Jackson & Scott-Jackson 2010).

However, possible geomorphological explanations for this have been largely ignored. On the shoulders of valleys and the scarp slope, other superficial deposits feather out to expose the Clay-with-flints *sensu stricto* (Catt 2010), increasing the potential for artefact release and leading to surface assemblages eroding at plateau and terrace edges. Soil erosion on the Chalk plateaux means that remaining deposits are now shallow enough for ploughing to uncover still buried artefacts (Halliwell and Parfitt 1993; Parfitt and Halliwell 1996; de Warrimont 2007). Only Harp (2005) directly raised the possibility that the presence of some sites on high ground between two valleys could be a coincidence of preservation and release, with sites close to the edge being exposed through erosion. In addition, a significant number of sites might still be buried at depth on areas of the plateaux not so far revealed by soil erosion or deep ploughing, which could alter the site distribution patterns and, consequently, interpretations of landscape preference significantly.

Drinkall (2013) applied a similar landscape approach to the British Palaeolithic, in an attempt to answer the same questions about whether early humans were using different parts of the landscape for different activities and whether this was linked to a site's position. She employed a combined technological, typological and châine opératoire methodology to determine assemblage signatures for a variety of landscape types including lowland, riverine, lacustrine, grassland plains and uplands. She then used GIS for her upland study areas – the North Downs of Kent and the Chilterns – to investigate sites' topographical positions, distance from major landscape features and viewsheds. Drinkall's upland areas are also core study areas for my research although Drinkall looked only at the few

primary context sites for each area, rather than the full archaeological record.

Drinkall analysed the assemblages from 9 upland sites in detail, with an additional 20 sites (4 Chiltern and 16 North Downs) included in her GIS analysis. It is worth noting, however, that some of these smaller sites – e.g. Slip End (Chilterns), Freedown, Broome Bungalows and Hacklinge (North Downs) - consist only of a single flake or artefact, which could simply have been lost in transit, rather than indicating deliberate site choice. All Drinkall's Chiltern sites were Worthington Smith discoveries, with almost all those on the North Downs being identified by Kent Archaeology Group. In total, she examined several thousand individual artefacts, while two of the Kent sites (Westcliffe Saint Margaret and Woodhill, Kingsdown) have been the subject of recent investigation and excavation. Drinkall looked also at 12 MIS12 to MIS9 lowland sites via printed sources, rather than direct investigation and analysis. Nine of these sites were from Suffolk and Essex plus Boxgrove (Sussex) Swanscombe (Dartford, Kent) and Red Barns (Hants), which lies at on the north-facing slope of Portsdown Hill on the outskirts of Portsmouth. None of these is in a lowland area bordering the Chilterns, with only Swanscombe sitting directly below the North Downs, which makes direct correlation between Drinkall's upland and lowland sites problematic.

Drinkall split the upland sites into those representing a 'mixed strategy' (with a multitude of activities taking place, including flint procurement, flaking and nodule reduction, and the production of finished tools) and 'resource extraction' sites. Only one (Malmains 2 on the North Downs) was identified as an 'ephemeral/episodic' location. The lowland sites were similarly mixed, regardless of whether they were riverine, lacustrine, or grassland, a pattern holding true for both the Chilterns and North Downs (Drinkall 2013).

Viewshed analyses, however, identified different patterns in the two areas. That for the Chilterns suggested a correlation between assemblage size and extent of viewshed, with the main sites having larger viewsheds than the smaller assemblages. Extensive viewsheds over the surrounding landscape were identified as being a factor in repeated visits and location selection. There was also an apparent correlation between distance from

the northern scarp and tool signature, with sites nearest the scarp edge and with access to the lowlands below having a focus on meat-related tasks, in contrast to those set further back on the plateau. For the North Downs, however, extent of viewshed did not appear to correlate with assemblage size and there did not appear to be any correlation between a site's position in the landscape and its flake tool signature. This was interpreted (Drinkall 2013, 348) as suggesting a less structured settlement system or mobility network south of the Thames, though the evidence to support this argument must be regarded as fairly tenuous.

Viewshed analysis has been described as the most valuable contribution of GIS to landscape study (Wheatley and Gillings 2000,1), but any interpretation based on the results of viewshed calculations must take into account the limitations of the DEM used (e.g. altitude errors, curvature of the Earth), absence of detailed coverage information (vegetation, built environment), effects of atmospheric conditions and the ability of the observer to clearly identify distant features (Llobera 2003, 29). Its use in Lower and Middle Palaeolithic archaeology is particularly open to criticism because of the difficulty in accounting for changes in topography and vegetation both during and since the Middle Pleistocene and the impossibility of establishing the contemporaneity of sites which can rarely be dated more closely than to within several hundred thousand years. However, Drinkall uses viewshed analysis purely as an experimental tool to gather additional information. Potential difficulties are recognised and dealt with, sites are treated separately not as a pattern within the landscape and her assumption that the general topography of the Chilterns and North Downs has remained broadly the same since the Middle Pleistocene is valid (for reasons I discuss in Chapter Five).

Overall, Drinkall's conclusions are similar to those of Kolen *et al.* (1999) and others. Upland sites may have been used as viewing platforms to oversee activity on the lowland plains and as 'gearing up' loci for tool production for transportation and use elsewhere. Lowland sites were essentially mixed, witnessing a wider range of activity types. However, her conclusion, based on their lithic signatures, that upland sites were primarily for carcass acquisition, processing and butchery while lowland sites were places for carcass processing (Drinkall 2013, 374) conflicts with prevailing

interpretations of riverine sites as lowland hunting grounds and with evidence from lowland sites such as Ebbsfleet and Boxgrove.

Although paying attention to the sedimentary succession for each of her sites and its implications for the archaeology and despite briefly discussing doline formation and the significance of dry valley formation processes and timing, Drinkall's analyses and conclusions make no allowance for the potential significance of bedrock difference or periglacial processes on site distribution patterns in the archaeological record.

vii) Lower and Middle Palaeolithic archaeology and deposits mapped as Clay-with-flints

Scott-Jackson (2000) was one of the first to look in detail at the relationship between upland Lower-Middle Palaeolithic artefacts and deposits mapped as Clay-with-flints. In addition to creating her gazetteer of >2000 Lower-Middle Palaeolithic artefacts found in relation to deposits mapped as Clay-with-flints, she founded PADMAC (Unit for the Study of Palaeolithic Artefacts and Associated Deposits Mapped as Clay-with-flints) at Oxford University in an attempt to understand the ways in which deposits mapped as Clay-with-flints formed and the nature of the processes which have acted upon them over geological time (Winton 2004).

Scott-Jackson argued that to fully understand the movements and activities of Palaeolithic people at any one point in time requires consideration of the landscape as a whole and of the relationship that exists between high- and low-level sites (Scott-Jackson 2000,viii). In many cases, valley-floor and river bed deposits are composed of material that has slumped down from higher-levels, making it is not unreasonable to suggest that at least a proportion of low-level finds have descended from high-level sites. I discuss the scale of this displacement in Chapter Nine below. Given the restricted changes that have taken place in deposits mapped as Clay-with-flints, *in situ* sites should exist on some of the high-level landscapes they still cap and Scott-Jackson (2000) identified a number of factors that could indicate areas warranting detailed archaeological investigation or survey. In particular, the presence of frost-shattered Chalk and (to a lesser degree) asymmetric valley-side slopes, could be used as standardised 'benchmarks' against which to measure levels of change/erosion on any specific area of Downland and establish how much or how little the deposits

mapped as Clay-with-flints have been affected. The archaeological potential of a specific hilltop or area could thus be established (Scott-Jackson 2000,13). Although not expressed in the same way, Scott-Jackson's focus on geomorphology and on the preservational and release qualities of deposits mapped as Clay-with-flints and the consequent implications for the archaeological record is very much in tune with the Unified Palaeolithic Landscape Approach which informs and underpins my approach in this thesis. On the South Downs, frost-shattered Chalk up to 2.5m deep underlies at least 80% of the land-surface (Williams 1986). Dip-slope dry valleys are often asymmetrical in cross-section, the result of periglacial stream erosion in the valley bottom, combined with solifluction and soil creep acting on the gentle slope and freeze-thaw processes on the steeper slope (French 1972).

Scott-Jackson carried out a test-case excavation (a single 3m x 1m trench) in 1993 at Wood Hill, Kent (TR371 480) a site previously excavated by Dover Archaeological Group (DAG) in 1984 and 1985. This, she claimed, was the first attempt at using modern scientific methods to address fundamental questions related to Lower and Middle Palaeolithic artefact survival on deposits mapped as Clay-with-flints. Auguring and resistivity survey in 1994 showed that the deposits mapped as Clay-with-flints on Wood Hill were contained in a 'basin like' solution feature, within which Scott-Jackson (2000) identified at least two Middle Pleistocene occupation levels, during which Lower-Palaeolithic people made at least three visits to Wood Hill. TL dating of two pieces of burnt flint found during the 1984/5 DAG excavations at Wood Hill produced dates of 380,000 ± 26,000 years and 200,000 ± 33,000 years, in a reversed stratigraphic position – a situation attributed by Scott-Jackson (2000) to geomorphological processes.

Both Scott-Jackson's excavation techniques at Wood Hill and the conclusions drawn have been questioned (Scott-Jackson 2000a, 66) on grounds that only a single trench was dug, with stratigraphy that was not level and with the sections for each of the four sides of the trench having different numbering schemes. The anthropogenic nature of the burnt flint has also been questioned and identification of two discrete artefact horizons disputed, with Scott-Jackson's explanation for the reversed stratigraphy being described as the least likely of many options (Scott-

Jackson 2000a; Scott-Jackson 2000b). In fact, on the basis of extensive field walking and excavation experience at Wood Hill, Halliwell has suggested that the Lower Palaeolithic artefacts form a coherent assemblage likely to be representative of a single phase of occupation (Winton 2004).

Scott-Jackson's older sample came from only 24cm below the surface, which could indicate disturbance by ploughing (Drinkall 2013). The processes leading to the infilling of solution hollows involve episodic input and reworking of sediment during periods of active solution formation. Including subsequent and possibly still ongoing erosional processes, they are likely to produce potentially complex sedimentary sequences. At a doline site at Westcliffe St Margaret's (TR 3745 4905), 4km south of Wood Hill, OSL dating was carried out on the brickearth sediments positioned stratigraphically below and above a clay and flint clast layer containing 650 excavated artefacts and debitage (Bailiff *et al.* 2013). The resulting dates placed the deposition of the artefacts between ~140ka and 80 ka, significantly later than the >300ka indicated by the artefact typology. If the artefacts had been incorporated into the hollow wholesale, within their original deposits, then the OSL dates should have corresponded with the typological date of the artefacts. However, the younger result suggested there had been soil movement surrounding the artefacts, the original deposition medium of which had been lost. Consequently, they were no longer *in situ* in their primary context. This could have been because the artefacts lay exposed on the plateau surface before being incorporated into the doline at a later date or, as indicated by Bailiff *et al.*'s (2013) analysis, the result of later influxes of sediments into the doline through rill and pipe formation becoming mixed with the earlier deposits. Geomorphological processes could similarly explain the reversed stratigraphy at Wood Hill, with an artefact from a later occupation becoming incorporated into the fill of the solution hollow, whilst an older artefact remained at a higher level on the edge of the feature (Scott-Jackson 2000a; Scott-Jackson 2000b). This possibility, which would explain the unlikely stratigraphic reversal, is ignored by Scott-Jackson herself.

PADMAC investigations at a number of other sites, including Dickett's Field, Yarnham's Farm, Holybourne Down, Hampshire and Arrewig Lane, Chesham, Buckinghamshire claimed to have shown that topographically

high-level Palaeolithic sites on deposits mapped as Clay-with-flints possessed a number of general characteristics (Scott-Jackson and Scott-Jackson 2008; Scott-Jackson and Scott-Jackson 2010; Scott-Jackson and Winton 2010). They:

- are located on the edges of plateaux and interfluves
- combine long views (e.g. across flood plains) with short views down into nearby valleys
- cccupy positions where knappable raw material was available locally
- both surface finds and what Scott-Jackson (2000) calls 'embedded' sites have been preserved in deposits in pipes and solution hollows in the Chalk and Palaeolithic surface-finds on high-level areas may be indicative of embedded site(s) in that area.

Scott-Jackson's argument that the topographical positions of these high-level sites may reflect Palaeolithic hunting patterns, where migrating game could be observed from a distance and subsequently hunted as the nearby valleys 'funnelled' game into restricted routes or passes (Scott-Jackson and Scott-Jackson 2010, 2) is in tune with the work of several others (Kolen 1999; Kolen et al.1999; Drinkall 2013) although she, like them, ignores the possibility of a geomorphological explanation for the apparent concentration of sites along the plateau/interfluve edges.

viii) Summary

In this chapter I have reviewed current interpretations of Middle Pleistocene social organisation (the Local Hominin Network, Social Landscape and Local Operational Area models), population modelling (the Deserted Britain model), regional colonisation hypotheses, landscape use hypotheses (Riparian Preference, Nutritional Niche, Routed Foraging, Persistent Place, Landscapes of Habit, Static and Mobile Resource models), hypotheses relating to patterns of upland and lowland living and Scott-Jackson's work on Middle Pleistocene archaeology and deposits mapped as Clay-with-flints. In all of these I have identified geomorphological factors the potential implications of which have, to a greater or lesser extent, been ignored when interpreting the archaeological site distribution patterns (Table 3.2).

The significance of the geomorphological history of an area for the creation of the archaeological record and, consequently, for site distribution patterns is discussed in Chapter Five. Failure to take into account the potential implications of bedrock difference, sediment preservation/location and periglacial processes (solifluction, sheetwash and doline formation/infill) for archaeological site distribution patterns is a frequent shortcoming in current interpretations of early human behaviour (Table 3.2). Periglacial processes have, arguably, had the greatest impact on the Chalk uplands yet many of these models fail to take into account the fact that, as a consequence of such processes, significant numbers of valley-bottom artefacts may have originated from the Chalk plateaux.

How sites in the archaeological record were formed is one of the fundamental questions for any regional archaeological model (Hosfield 1999). Of the wide range of external factors (ecological, historical, anthropogenic and geomorphological) that have impacted on the creation of that record, it is geomorphological processes which have been the most widely disregarded in current models of early human landscape preference. My primary aim in this research has been to establish the scale of the geomorphological changes that have taken place in the Chalklands of southeast Britain and northern France since the Middle Pleistocene and to consider their implications for current interpretations of the Palaeolithic archaeological record since the Middle Pleistocene. The methodology by which I have done so is described in detail in Chapter Four.

Taking the UPLA approach of considering how all parts of the known Palaeolithic record from all parts of the landscape have been preserved and/or become visible, I have sought to redress the imbalance between the perceived significance of the upland and river valley archaeological records and bring the role played by plateau, interfluve and escarpment-edge locations into sharper focus. By integrating geomorphology and landscape processes into interpretations of past human behaviour, I have addressed the exclusion of large areas of Pleistocene archaeology (that of the uplands) from models of early human landscape use and enabled the formulation of more robust behavioural interpretations.

Table 3.2. Geomorphological criticisms of current interpretations of Middle Pleistocene human landscape use.

Model/hypothesis	Geomorphological Criticism
Social organisation – LHN, SL and LOA models	Raw material transport distances used to estimate range size in areas of one type of bedrock, or a particular landform (caves) cannot necessarily be transferred directly to areas on other bedrock. Results which have not been universally tested cannot be universally assumed.
Population modelling – the Deserted Britain hypothesis	The preservation/loss and distribution of sediments dating to a particular glacial/interglacial cycle will impact on evidence of human presence/absence during that cycle. Assumption of absence from Britain during MIS4-6 without taking into account the widespread loss of sediments from that period and the neglect by archaeologists of those sediments which do survive will result in questionable interpretation.
Regional Colonisation Pattern hypothesis	A primary focus on changing access routes and technological changes in the record has led to insufficient attention being paid to differential survival/loss of superficial deposits in different areas, or to other potential distorting factors such as collector bias and/or aggregates extraction patterns.
Landscape use – the Riparian Preference model	Ignores the fact that flint-rich Chalk bedrock outcrops extensively across the plateaux, offering high-quality flint raw material to humans, The effects of periglacial processes (solifluction and soil-slumping) which could have carried plateau archaeology in Head deposits down into river valleys and the fact that ponded dolines and, at a time of higher water tables, Chalk-slope springs and streams would have provided water for humans and game alike are also ignored.

Model/hypothesis	Geomorphological criticism
Landscape use – the Nutritional Niche hypothesis	Ignores the fact that marked concentrations of the richest pre-MIS5 sites (those with >500 bifaces) in the lower reaches of river-valleys could be the result of changes in bedrock, with rivers with steeper gradients off-loading their gravels, together with any artefacts contained, on reaching shallower gradients. River confluence points could similarly have generated a decrease in water velocity, resulting in deposition of gravels and contained artefacts transported from other source areas.
Landscape use – Persistent Places and Landscapes of Habit	Persistent places may have been simply accidents of geomorphology, places with long-lived capture points for Pleistocene sediments in which archaeology could be preserved.
Landscape use – the Static and Mobile Resource model	Testing of this model depends on the long-term stability of a location and the degree of archaeological and environmental resolution available. It cannot take into account sites where resolution is poor or there has been landscape instability due to periglacial processes.
Patterns of upland and lowland living – Site Location Preference and Differentiation of Activities	Apparent plateau-edge site location preference may be the result of weathering of superficial deposits on valley shoulders and scarp slopes and/or soil erosion on plateaux increasing the potential for artefact release. No allowance is made for the potential significance of periglacial processes (solifluction and sheetwash) or bedrock difference on site distribution patterns.
Scott-Jackson – Lower-Middle Palaeolithic archaeology and deposits *mapped as Clay-with-flints*	Geomorphological processes (doline formation and/or subsequent infilling by sediments) could account for the reverse stratigraphy of Scott-Jackson's *excavation at Wood Hill, interpreted by her as at least two separate* Middle Pleistocene occupation levels

Chapter Four. Materials and Methods

i) Introduction

My concern in this thesis is with the reconstruction of Lower-Middle Palaeolithic human behaviour and landscape use in the Chalklands of southeast Britain and northwest France based on distribution patterns in the archaeological record, and with the biasing factors involved in the creation of those patterns. These include the ecology, collector history, industrial activity (aggregates and brickearth extraction), urbanisation and infrastructure development, geomorphology and land-use history of an area (Table 1.1, Chapter One). There have recently been several bold interpretations of early human behaviour that have taken into account most of these potential biasing factors (Ashton 1998; Ashton and Lewis 2002; Ashton *et al.* 2006; 2015; 2016*;* Brown *et al.* 2013; Drinkall 2013; Hosfield 1998;1999; 2016; Kolen *et al.* 1999; Scott and Ashton 2011; Scott and Shaw, 2018; Shaw *et* al. 2016; White *et al.* 2006; White and Pettitt 2011). However, with the exception of patterns of colonisation of Britain (Ashton 2002; Ashton *et al.* 2015; Ashton and Hosfield 2010; Ashton and Scott 2016; White 2015) the impact of geomorphological processes has been either ignored (e.g. by Brown *et al*. 2013; White and Pettitt 2011) or considered only incidentally. In this respect, Scott-Jackson's work on Clay-with-flints (Scott-Jackson 2000; Scott-Jackson and Scott-Jackson 2008; Scott-Jackson and Winton 2001) and Hosfield's studies of the Hampshire Basin (1998; 1999; 2005) continue to be the exception, rather than the rule. My starting point for this research was, therefore, the need to assess current behavioural interpretations in light of my understanding of the geomorphology of the Chalk lands in my core and control study areas.

Antiquarian collectors were responsible for 85% of known finds locations for the British Lower-Middle Palaeolithic (Harris' *et al.* 2019), taking advantage of the collecting opportunities presented by the exposure of large areas of Pleistocene deposits during late 19th/early 20th century industrialisation. It was, therefore, important also to establish the impact of antiquarian collecting and industrialisation on findspot distribution patterns and assess the consequent implications for interpretations of early human behaviour.

The Unified Palaeolithic Landscape Approach (UPLA) suggests that artefact preservation and release and hence the distribution of the

archaeological record, will be strongly controlled by geomorphology. For reasons explained in Chapter Five, Clay-with-flints survival makes a good proxy for the degree of erosion suffered by the Chalk uplands of southeast Britain and the preservation of palaeo-landscapes during the Pleistocene and Quaternary. Testing the impact of differential Clay-with-flints survival on the distribution of the archaeological record for the English Chalklands was therefore, a key part of my research, based on my working hypothesis that where little Clay-with-flints survives finds will mostly have eroded away. Where dense Clay-with-flints survives, finds will be obscured by the geology. Between these extremes there will be optimal conditions for artefact recovery and release. If geomorphology, not human behaviour, is the prime control over recorded artefact density, then the relative abundance of upland findspots should increase and decrease proportionally to Clay-with-flints survival within any given landscape. If correct, this has significant implications for the use of artefact distribution patterns to interpret early human landscape use. In this chapter, I explain the methodology I used to test this hypothesis.

My methodology involved:

- Reviewing the geomorphological literature to develop an understanding of the impact of landscape change since MIS12 on the archaeological record of the Chalklands of southeast Britain and northwest France and producing a model of landscape change based on that understanding;
- Developing a GIS-based approach to test the implications of geomorphology for findspot distribution patterns;
- Compiling a Chalklands Lower-Middle Palaeolithic dataset of 1772 entries for my core study areas (the North and South Downs and the Chilterns of southeast Britain) and 167 for the Hauts-de-France administrative region of northwest France (Somme, Aisne and Oise départements);
- Creating geological findspot distribution maps for my core and control study areas to identify the geological context of each findspot;
- Analysing the relationship between the geological contexts of the findspots in my dataset and surviving Clay-with-flints superficial deposits;

- Analysing the circumstances of each discovery - late 19th/early 20th century industrialisation (including aggregates extraction, urbanisation and infrastructure building) and antiquarian collecting;
- Identifying the differences between English and French national heritage management policies and research strategies for archaeology;
- Analysing the effect of all of the above on the archaeological record and findspot distribution patterns;
- Assessing the implications for current interpretations of early human landscape preferences.

Current interpretations of early human landscape use are reviewed critically in Chapter Three of this thesis in the context of the general geomorphology of the Chalklands as described in Chapter Five. The results of the detailed analyses described in the current chapter are presented in Chapters Nine and Ten, together with an evaluation of their implications for the use of archaeological findspot distribution patterns to interpret early human behaviour.

ii) Development of a geomorphological model of landscape change.

Based on my understanding of the geomorphological processes affecting the Chalk uplands since MIS12, I developed the following model of landscape change for my core and control study areas. The geomorphological bases for the model are explained in detail in Chapter Five of this thesis. My model envisages that:

- Since MIS12, the Chalk interfluves have undergone only limited erosion, modified primarily by dissection and gentle surface lowering as a result of dissolution of the subsurface. Limited amounts have been lost through solifluction. Consequently, the general topography of the Chalk downland today differs in degree rather than kind from that of the late Middle to Late Pleistocene;
- The southward diversion of the river Thames between MIS12 and MIS6 notwithstanding, pre-existing drainage lines were largely maintained in the chalklands of southeast Britain, although deepened and modified under later periglacial conditions;

- Incision of river valleys occurred broadly in synchrony with 100,000 year Milankovitch cycles, with a median incision rate of 10m per cycle;
- Although deepened by later periglacial processes, the pattern of dry valleys has existed since at least the Middle Pleistocene;
- Sea-level changes also occurred synchronously with 100,000 year climatic cycles but, with the exception of the breaching of the Weald-Artois anticline, their effects were limited. They were at least partly contained by fluvial course lengthening and shortening, with little imperative for incision or aggradation and did not extend far up-basin.

iii) Development of a GIS-based approach to testing the implications of geomorphological factors for the archaeological record

Given that the Lower Palaeolithic lies at the frontier between geology and archaeology (Bridgland 1996) I developed a GIS-based approach to testing the implications of geomorphology for findspot distribution patterns using the British Geological Survey (BGS) data available via EDINA Digimap. ArcGIS then enabled me to produce maps of bedrock and superficial deposits for my British study areas, against which I subsequently plotted all Lower-Middle Palaeolithic findspots/sites in my dataset from those areas to identify their geological and topographical context.

There are some unavoidable uncertainties inherent in using geological mapping and findspot data in this way. First, the British Geological Survey have been surveying Great Britain for >100 years. The maps have all been surveyed at different times and to emphasis different features and as the rocks have not changed over time some of the earlier surveys are still used today. However, they were never made to be used with the surrounding maps, let alone combined in digital mapping and as a result it is sometimes possible to see where the older maps join up with the newer ones (see Fig. 4.7). Additionally, the British Geological Survey does not map superficial deposits <3m deep and when ground-truthing deposits such as Clay-with-flints these are often found to cover a bigger area than is suggested by BGS mapping (*pers. com.* D. Garton 22nd May 2016). Similarly, for many findspots listed in SRPP/TERPP, particularly the older entries which

constitute 85% of the British record, the Ordnance Survey National Grid references given are 'General' (i.e. accurate only to parish or district level and taken from the middle of the place concerned or some convenient feature within it). Nevertheless, this did not constitute a fundamental problem because a sufficiently large number of the map references are either 'Accurate' (i.e. accurate to a precise location) or 'Estimated' (i.e. estimated in relation to some name or feature and accurate to within 250m depending on the local topography). For example, in Wymer's (1999) map synthesis of the SRPP/TERPP project, 62% of the North Downs sites mapped on the interfluves either side of the river Darent (Map 48), 69.5% of the Chiltern sites between the Dunstable and Hitchin gaps (Map 52) and 78.5% of the sites around the rivers Test and Itchen (Map 28) were classified as either A or E. Given the landscape scale of my research, the number of 'A' and 'E' findspots is thus sufficient to allow confidence in any distribution patterns identified and 'General' NGRs can still be regarded as informative.

iv) Creation of site lists – sources, methodological conventions and search terms used.

British site lists

Britain is in the unique position of having national databases of virtually all Lower-Middle Palaeolithic artefacts and their locations (Ashton *et al.* 2018; Roe 1968; Wessex Archaeology 1993a, b, 1996; 1997; Wymer 1999) as well as the Archaeology Data Service (ADS) website (http://archaeologydataservice.ac.uk/). The bulk of my British data was drawn from Wessex Archaeology's 1993 Southern Rivers Palaeolithic Project (SRPP) and 1996 English Rivers Palaeolithic Project (TERPP). Intended to enhance Roe's (1968) *Gazetteer of British Lower and Middle Palaeolithic Sites*, these surveys of Pleistocene fluvial sand and gravel deposits in the various river valleys and their archaeological deposits were funded by the then English Heritage (now Historic England) in response to the accelerating extraction of fluvial sand and gravel in Britain for road building and construction. Compiled from all relevant entries in each county's *Sites and Monuments Record* (SMR), with checking of museum collections, contact with professional and amateur archaeologists, local geological Memoirs, the latest British Geological Survey maps and site

visits when necessary, SRPP/TERPP provides eight categories of information for each site – provenance and circumstances of discovery, geology, SMR reference number, SRPP/TERPP map number, known archaeological material, published sources and present state of the site. The information was also plotted on base maps at a scale of either 1:50,000 or 1:25,000, depending on the density and significance of evidence recovered.

The occurrence of Palaeolithic artefacts within geological sediments has been recorded in England since the late 17th century and, from the end of the 18th century, the growing body of such discoveries was vital to international debates on the true antiquity of the human race (Wainwright 1999). In SRPP/TERPP, the geological deposits recorded as contexts in which palaeoliths in my core study areas were found include terrace gravels, Clay-with-flints, Head deposits, Head and Clay-with-flints, Chalk, glacial sand and gravel, brick-earths, dry valley deposits, raised beaches and surface discoveries. I also consulted hard-copy geology maps during the compilation of my dataset, enabling me to omit places lying well outside the Chalk areas (e.g. Bedfordshire findspots in the Ouse Valley and Kent sites lying on the Weald).

Shaw and Scott (2016) defined a Palaeolithic archaeological site as a location providing evidence upon which inferences about past environments can be built, thus contributing to an overall understanding of early human adaptations. In SRPP/TERPP each recorded 'site' is treated as a single findspot for mapping purposes, regardless of the number of artefacts found there and for consistency I have followed the same convention in my research.

I created Excel spreadsheets for each study area, drawn initially from the SRPP/TERPP electronic database. I then cross-checked these lists against the SRPP/TERPP hard copy reports and added any additional findspots. A significant number of findspots in each of the regions was found to have been omitted from the electronic database, including some key sites such as Ash-cum-Ridley, Kent, for which the electronic data includes only a single site (Bettys Maple TQ 561 1637). The hard copy, however, lists 7 findspots, including the major site at West Yoke (TQ 597 655), where 31

artefacts were found, including 21 handaxes, 1 roughout and 8 flakes, 1 of which is Levallois.

I next cross-checked the Historic England Heritage Gateway database (https://www.heritagegateway.org.uk/Gateway/) and/or the Historic Environment Record (HER) for each local authority in the study region against my lists. These included the modern counties of Berkshire, Oxfordshire, Buckinghamshire, Hertfordshire and Bedfordshire (for the Chilterns), Surrey and Kent (for the North Downs), East and West Sussex and Hampshire as far west as the River Test (for the South Downs), four London Boroughs (Bexley, Bromley, Croydon and Sutton), three unitary authorities (Reading, Portsmouth and Southampton), plus Winchester and Windsor and Maidenhead, which maintain separate HERs from their respective county councils. In most cases, local HERs were available via the relevant local authority websites but I had to visit Surrey and Bedfordshire HER offices to consult their data.

The search term I used in all cases was 'Palaeolithic' because using the more specific 'Lower' or 'Middle' Palaeolithic failed to identify sites where Lower and Middle Palaeolithic material formed only part of the finds. Using the search term 'Palaeolithic' brought up all sites with material dating from 500,000 BC to 42 A.D. and I then made a decision about inclusion or omission, based on the content of each entry. I made no attempt to distinguish between entries for the Lower or Middle Palaeolithic as the division between the two periods is nuanced in Britain and the archaeology of both periods has been equally susceptible to the factors controlling their preservation or release into the archaeological record. Where entries did not specify a particular Palaeolithic period I included the findspot for completeness but any specifically Upper Palaeolithic sites were excluded, as were sites consisting only of a single undifferentiated Palaeolithic flake, or if the Palaeolithic designation was merely 'suggested'. I likewise omitted sites described as 'Prehistoric 500,000 BC – 42 'AD' or 'Prehistoric?' as being too vague, although in one or two cases (e.g. Buckinghamshire HER 422201 Chalfont St Peter) sites described as 'Prehistoric' in the HER nevertheless appeared in the SRPP/TERPP data and were, therefore included on my lists.

Where Heritage Gateway/HER entries appeared to pre-date SRPP/TERPP and might, therefore, be expected to have been included in the project, I considered any additional information available, in an attempt to establish the reason for omission and, particularly in the case of very early entries, to avoid including eoliths. References were followed up and verification of a findspot's inclusion in Roe's 1968 Gazetteer, Wymer's "Lower Palaeolithic Archaeology in Britain" (1968), Roe's "The Lower and Middle Palaeolithic Periods in Britain" (1981) or reputable journals such as *Archaeologia Cantiana, The Antiquaries Journal* or *Proceedings of the Prehistoric Society of East Anglia* was regarded as satisfactory validation for an entry. I also checked the Solent Thames Archaeological Framework (http://oxfordarchaeology.com/research-projects-by-name/217-solent-thames-research-framework) for the Chilterns, the Stopes Palaeolithic Project Final Report (http://archaeologydataservice.ac.uk/archives/view/stopes_eh_2007/index.cfm) for the North Downs, Woodcock (1981) for the Sussex Downs and copies of Benjamin Harrison's manuscript distribution maps, stored in the Maidstone Museum. Grey literature references were followed up during my visits to Hertfordshire, Oxfordshire, Surrey and Bedfordshire Historic Environment Offices and a number of 19th and very early 20th century entries were, ultimately, excluded because of insufficient means of validation.

Where there was conflicting information between the SRPP/TERPP and HER data for a particular HER number, I gave preference to the HER. For example, the Berkshire HER states that No. 01737 relates to 94 Church Road Reading. The SRPP/TERPP data states that it relates to Halls Road, Calcot, Reading. The HER number was, therefore, deleted from the TERPP reference and a separate entry created for 94 Church Road.

I also searched the Portable Antiquities Scheme (PAS) database (https://finds.org.uk/database/) for all relevant local authorities because some, such as Oxfordshire, exclude PAS finds from their HER. My search term was again "Palaeolithic", identifying a number of recent finds which would not otherwise have been noted. I secured 'researcher' status to enable me to access detailed grid reference information and where entries were inaccessible because still under review I contacted the relevant Finds

Liaison Officer who, in all but one case, was able swiftly to review the records and make them available.

One thousand seven hundred and seventy two (1772) findspots were identified through this process. (Fig. 4.1 Sample Data Sheet).

Issues encountered

SRPP/TERPP is a superb archive upon which much of the research on British Pleistocene archaeology during the past two decades has been built (Chauhan *et al.* 2017). However, the primary purpose of the SRPP/TERPP was to study and record surviving Pleistocene deposits in a given region that contained, or might contain, Lower-Middle Palaeolithic sites and artefacts so that recommendations could be made when commercial threats to such deposits arose. It was never intended as an archaeologist's distribution map (Roe 1996) although frequently used as such. Nevertheless, SRPP/TERPP did, for the first time, offer a comprehensive, collated resource documenting the distribution of Lower and Middle Palaeolithic findspots, relevant Quaternary deposits and past, present and future aggregate sites (Hosfield 1999).

The SRPP/TERPP, HER and Portable Antiquities databases are all invaluable sources of information but it required great care to produce an accurate database because:

- The SRPP/TERPP data does not include HER numbers for many sites, necessitating rigorous cross-checking to avoid duplication or omission;
- The SRPP/TERPP data frequently amalgamates several HER entries, giving a centred grid reference but without all HER numbers e.g. Aylesford, Kent for which there are eight separate HER entries but only one SRPP/TERPP entry centred on TQ 30 590);
- Site location names sometimes differ – e.g. Kent HER describes entry TQ57 NE1000 as "Dartford Tunnel" but it is "Stone, Kent" in the SRPP/TERPP hard-copy. Similarly, the site described as Wood Hill, Kingsdown by Scott- Jackson (2000) and Parfitt and Halliwell (1996) appears as "Ringwould with Kingsdown" in SRPP/TERPP. On the South Downs, Woodcock identifies a site as "Folkington (sometimes attributed to Wannock)" but TERPP calls it "Willingdon"

and mentions “Folkington Hill, Wannock” only in subsidiary information. Similarly, Woodcock’s “Friston” is SRPP/TERPP’s “East Dean”;

- The SMR references for the London boroughs are sometimes also included in the relevant county HER (e.g. Bexley 070559 and TQ57 NW107 Kent) creating a danger of duplication. Similarly, HERs may allocate the same number to two separate entries. For example, TQ57 SE161 is applied both to “Former Stonewood Brickyard (Site of)” and “Palaeolithic Find. The Brent, Dartford”, creating the risk of omission;
- Occasionally there is no NGR given in the HER – e.g. TQ57 NW107 “Norris Pit, Erith” for which the NGR had to be obtained from SRPP/TERPP hardcopy (this key site is missing from the SRPP/TERPP electronic database);
- Grid references for the same site do not always match in SRPP/TERPP and the HER –e.g. HER numbers TQ57 SW121 “Dartford (West Hill Road School)” and TQ96 SE102 “Teynham” on the North Downs, or MWS 5928 “Lavant” in Sussex. “Fittleworth, Coates Common Pit”, Sussex is given the NGR SU 998179 in Woodcock, SU 997172 in the HER and SU 030174 in SRPP. Where such differences were found I gave preference to the grid reference agreed by SRPP/TERPP/Roe/Wymer rather than that of the HER;
- When I used the SRPP/TERPP grid references for mapping, it occasionally became clear that an incorrect NGR had been given. Examples include Southampton MSH 1847 “Itchen Valley handaxe”, where the SRPP NGR was 444000 150000 but should have been 444000 115000. Similarly, Southampton MSH 4321 NGR was given as 443000 147000 but should have been 443000 114700. Although clearly typographical errors, these provided another indication that the data must be used with care;
- The picture is complicated further for the South Downs because SRPP/TERPP gives only outdated Sites and Monument Record numbers which bear no resemblance to current HER numbers for the same sites – e.g. “Fittleworth Coates Common” is SMR 1604 in TERPP but MWS 2469 in the HER;

- I encountered significant difficulty with the Buckinghamshire PAS, where 137 out of a total of 145 Palaeolithic artefacts were recorded as being “on review” (i.e. unavailable) in the same parish. Correspondence with the Buckinghamshire Finds Liaison Officer (FLO) established that these were from a single finder, a University Masters student who, in 2009, was convinced he had found a new site. Although his (unknown) supervisor considered his material to be valid but controversial, the FLO was unable to confirm their validity and the PAS Advisor on lithics “quarantined” two of the artefacts because he did not accept their authenticity. The FLO, not a lithics specialist, supplied me with a copy of the raw data for the finds which established that the find date for all but four of the entries was the same. Additionally, the finding of such a large number of genuine Lower-Middle Palaeolithic surface artefacts in a single parish would be hugely out of proportion to the number of Portable Antiquities finds recorded from any other area. I therefore omitted these artefacts from the study. This episode raised questions about the variable quality of entries on the PAS database, especially for Palaeolithic archaeology;

- SRPP/TERPP provides an assessment of past quarry locations and extents. However, most upland brickearth pits and many gravel pits were relatively small-scale and locally focused, opening and closing in response to local need – e.g. the gravel pit at Wiggonholt, Sussex was opened in 1904 specifically for road repair at Parham (Garraway Rice 1905). Hosfield (1999) identified inaccuracies in the SRPP data, including the absence of many such smaller, short-lived quarries identifiable on historic maps. The timing and/or scale of individual quarry activity was crucially important in terms of the potential opportunities it provided for artefact collecting but the SRPP/TERPP data is time-averaged (Ashton and Hosfield 2010), preventing an examination of the impact of quarry distribution at particular points in time and a clear delineation of quarries pre- and post-mechanisation (Davis 2013). Variation in collector intensity is, however, likely to have played an important role in shaping the archaeological record and gravel pits coinciding with periods of peak collecting intensity probably produced more artefacts than

gravel exposures that coincided with a lull in collecting activity. Davis (2013) analysed the timing of recovery of artefacts in the Bournemouth and Test areas to identify fluctuations in collecting intensity but the scale of my study region unfortunately made a similar exercise impractical. Between 1898 and 1903, however, at least two of the main Caddington brickyards closed down and the artefact supply had dwindled (Sampson 1978). By 1906, Worthington Smith had stopped collecting at Caddington and transferred his activities to Round Green and other sites in Luton. As my research is concerned with the impact of a number of external factors on the preservation/release of artefacts into the extant archaeological record, rather than with identifying trends in that record, I nevertheless assessed the SRPP/TERPP data as adequate for my purposes despite its limitations.

French sites list

All my French sites are in what is now the Hauts-de-France administrative region, which came into being on 1st January 2016 as a result of a territorial reform of French regions that merged the former regions of Picardie and Nord-Pas-de-Calais. In total, I listed 167 Hauts-de-France sites, 133 in the Somme, Aisne and Oise départements and 33 in the immediately adjoining Nord-Pas-de-Calais. The location of 1 site referred to in the literature (Le Carmel) proved impossible to identify but I retained it in the list because the circumstances of its find (during motorway construction) were known.

In the absence of any French equivalent to SRPP/TERPP, HER or PAS and with difficulties in accessing French digital data and accurate map co-ordinates, compiling my list of French sites was problematic. My comparatively short list of findspots was drawn from French and English published journal articles and books, including publications by early collectors such as Victor Commont and Edmond Vignard or A. Salomon, Director of Roads and Bridges at Hermies, relating to the construction of the Canal du Nord. I then spent a week at the Directions Régionales des Affaires Culturelles (DRAC) Service Régional de l'Archéologie in Amiens consulting their archive of archaeological reports. Unfortunately, the DRAC archive is searchable only by site/place name, not by chronological period.

Fig. 4.1 Sample data sheet

Site	HER ref	X	Y	Geology	
ADDINGTON	TQ 65 NW 45	564800	159200		
ASH-CUM-RIDLEY (Pit Field)		560500	164500	Clay-with-flints	Ditto
ASH-CUM-RIDLEY (Betty's Maple)		561000	163700	Chalk	
ASH-CUM-RIDLEY (Clads)		560500	164500	Clay-with-flints	Ditto
ASH-CUM-RIDLEY (Highbury)		560500	164500	Clay-with-flints	Ditto
ASH-CUM-RIDLEY (North Ash, New Ash Green)		560500	165500	Clay-with-flints	2 handaxes
ASH-CUM-RIDLEY (Turners Oak)		560500	164500	Clay-with-flints	Ditto
AYLESFORD	TQ 75 NW 177	573000	159000		
AYLESFORD	TQ 75 NW 174	571800	158350		
AYLESFORD	TQ 75 NW182	573000	159000		
AYLESFORD	TQ 75 NW 181	573000	159000		
AYLESFORD	TQ 75 NW175	573000	159000		
AYLESFORD	TQ 75 NW 178	573000	159000		
AYLESFORD	TQ 75 NW 179	573000	159000		
AYLESFORD	TQ 75 NW126	573000	159000		
AYLESFORD	TQ 75 NW 197	573000	159000		
AYLESFORD (Bluebell Hill)	TQ 76 SW 98	574500	162600	Mainly Clay-with-Flints in this area	
AYLESFORD (Bryce's sand pit, Forstal Road)	TQ 75 NW 180	573400	158800	Terrace 1	
AYLESFORD (Near Kits Coty)	TQ 76 SW 99	574500	160800	Head	
AYLESFORD (Nickel or Niko Pit)	TQ 75 NW 23	572200	159500	Terrace 2	
AYLESFORD (Quarry)	TQ 75 NW 33	572200	157500	Mapped as Hythe Beds but probably Terrace 2	
AYLESFORD (sand pit near Preston Road)		572400	158000	Terrace 2	
AYLESHAM (46 Newman's Road)	TR 25 SW 29	623100	152300	Upper chalk	
BARHAM		621000	150000		
BEAN (Lord's Wood Lane)	TQ 57 SE 214	558000	171800	Plateau Gravel at c. 90 m O.D.	
BEAN (Stonewood Brickyard)	TQ 57 SE 161	559880	172530	London Clay	
BEAN (Stonewood Brickyard)	TQ 57 SE 215	559880	172530	London Clay	
BEKESBOURNE WITH PATRIXBOURNE		619500	155500		
BEKESBOURNE WITH PATRIXBOURNE (Howletts)		619600	156700	Head Brickearth	
BEXLEY (Crayford or Erith)	70474	551500	177000	Brickearth	Large numbers of handaxes, flakes, & Levallois found at this site &070449; probably all from Stoneham's Pit
BEXLEY (Crayford or Erith)	70449	551500	177000	Brickearth	See 070474 above
BEXLEY (Crayford)	70316	441800	174800		8 handaxes, 17 flakes (inc. 1 retouched), 1 Levallois core, 96 Levallois flakes found in general Crayford area
BEXLEY (Crayford, Rutters Pit)	70448	551400	176500	Brickearth	
BEXLEY (Crayford, Stoneham's Pit)	70460	551800	175800	Brickearth and gravels banked at "Levallois working floor" excavated by Spurrell	
BEXLEY (Crayford, Stoneham's Pit)	70476	551800	175800	Ditto	
BEXLEY (Erith Furners Old Pit)	70559	551900	176800	Brickearth	Ditto
BEXLEY (Erith Marsh)	70523	550000	178000		2 'surface' Palaeolithic flint implements found near each other
BEXLEY (Erith Norris' Pit)	70561	551400	176700	Brickearth	
BEXLEY (Foots Cray, Crittals Corner)	70512	547100	170400	Brickearth or flood plain gravel	Handaxe
BEXLEY (Grounds of Northumberland School)		550500	177000		2 handaxes

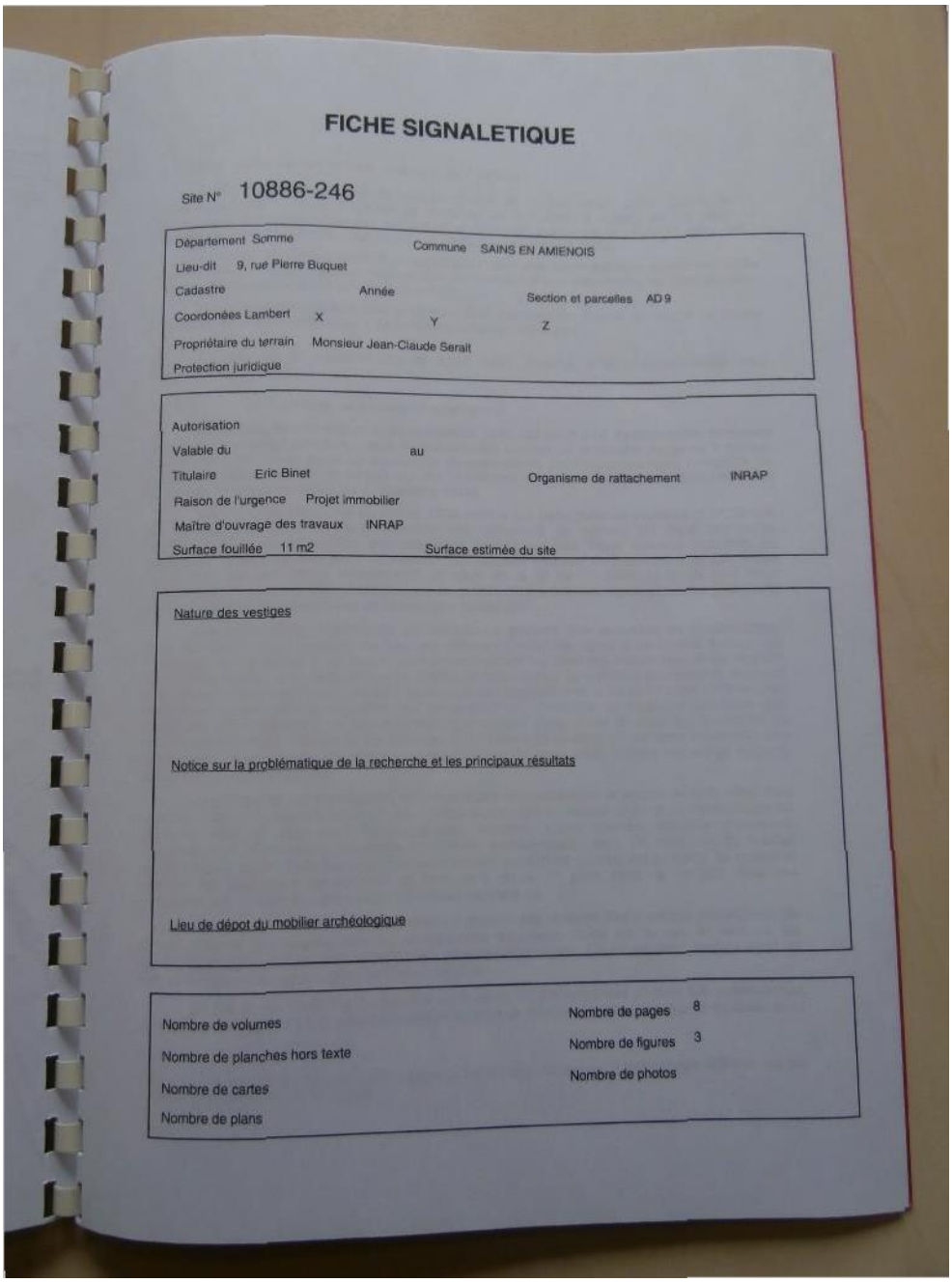
It includes reports for all recent developments where archaeological intervention has taken place, on whatever scale, meaning that I checked a multitude of negative reports because they related to places with the same name as one of my listed Middle Pleistocene sites.

The new région of Hauts-de-France includes the départements of Aisne, Nord, Oise, Pas-de-Calais and Somme. Of these, Aisne, Oise and Somme were in the former Picardie region, so were covered by my research in Amiens. Because of French Government policy not to publish the map co-ordinates for archaeological sites (E. Goval *pers comm.* 10th April 2016) very few archaeological reports in the DRAC repository record the co-ordinates of the site in question (Fig. 4.2). As a result I established Lambert co-ordinates for only 51 sites from the reports, identifying a further 4 with the assistance of staff in the Service Régional de l'Archéologie. Where co-ordinates are recorded, the older reports use the Lambert 1 co-ordinate system, the later ones Lambert 93, usually without specifying which.

In France, cadastral numbers are often used instead of map co-ordinates for archaeological site locations. A cadastre is a public register of the dimensions and area, value and ownership of an individual parcel of land, together with its precise location (Fig.4.3). Although cadastral references show a very precise location for an archaeological site within its town, village or commune, their translation into inevitably less precise map co-ordinates for use with GIS would have required an enormous amount of work and was beyond the scope of my research. For sites for which it was impossible to secure accurate Lambert 93 co-ordinates I therefore used the location of the nearest town/village/commune to produce my French site distribution maps (Maps 4.2 - 4.4).

As a week in Amiens established map co-ordinates for only 40% (55) of the former Picardie sites, some in Lambert 1 and some in Lambert 93, a trip to the Nord-Pas-de-Calais archive in Lille to secure map references for perhaps 14 additional sites (40% of 34) would not have been worthwhile

Fig. 4.2 Fiche signaletique (data sheet) without map references



FICHE SIGNALETIQUE

Site N° 10886-246

Département Somme Commune SAINS EN AMIENOIS
Lieu-dit 9, rue Pierre Buquet
Cadastre Année Section et parcelles AD 9
Coordonées Lambert X Y Z
Propriétaire du terrain Monsieur Jean-Claude Serait
Protection juridique

Autorisation
Valable du au
Titulaire Eric Binet Organisme de rattachement INRAP
Raison de l'urgence Projet immobilier
Maître d'ouvrage des travaux INRAP
Surface fouillée 11 m2 Surface estimée du site

Nature des vestiges

Notice sur la problématique de la recherche et les principaux résultats

Lieu de dépot du mobilier archéologique

Nombre de volumes
Nombre de planches hors texte
Nombre de cartes
Nombre de plans
Nombre de pages 8
Nombre de figures 3
Nombre de photos

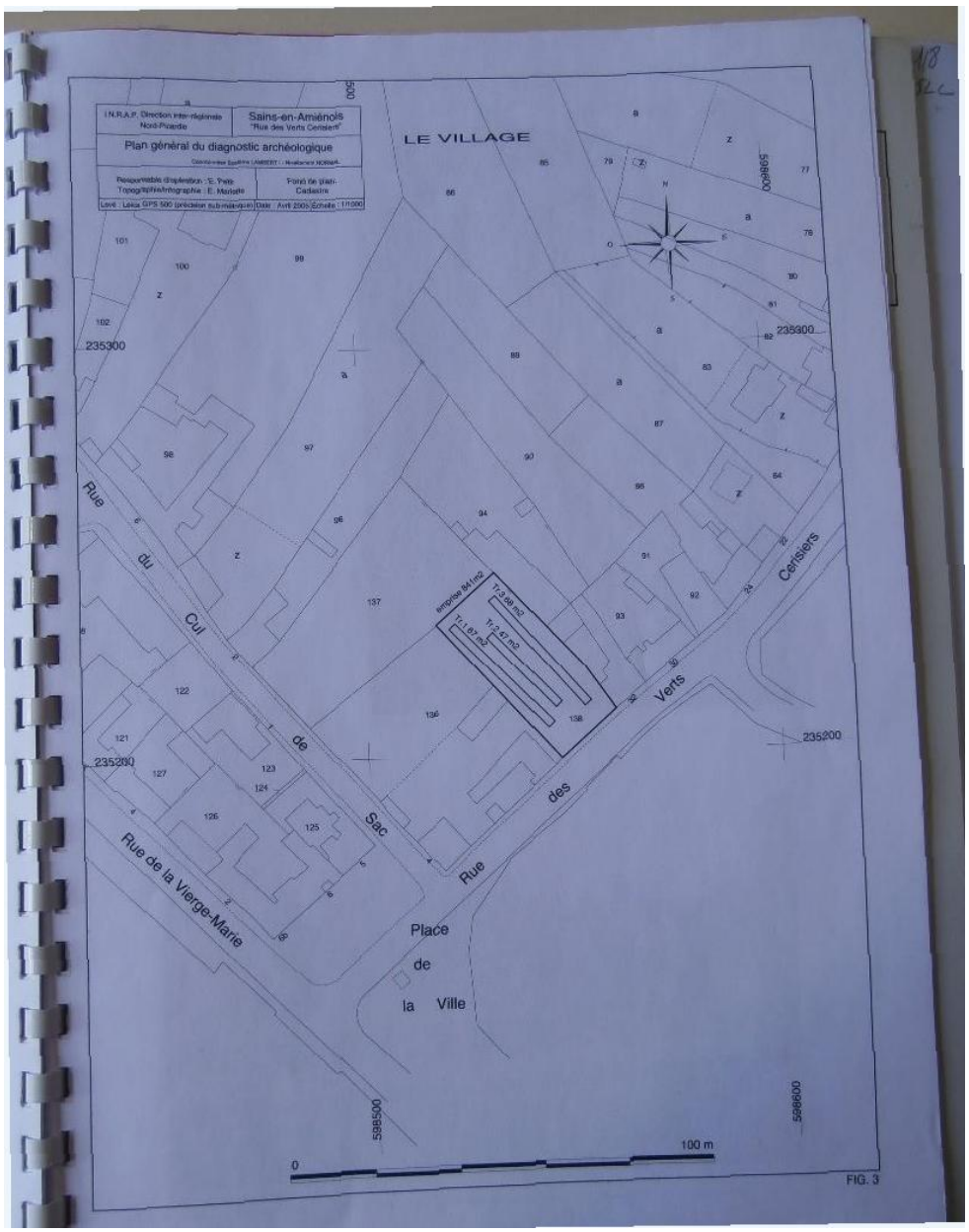
(Photograph by L. Blundell)

v) Creation of geological findspot distribution maps.

I created geological maps for my core study areas using ArcGIS software and British Geological Survey (BGS) data downloaded from Edina Digimap. I also used hard copies of the BGS geology maps for each study area for closer examination and to identify individual facies of Chalk. I then used ArcGIS to plot my 1772 findspots against the digital geological maps (e.g. Map 4.1).

Multiple find spots with the same NGR receive only a single marker on ArcGIS-generated maps. I considered amending such NGRs slightly (e.g. from 551500 177000 to 551501 177001) to make them show separately. However, this would have involved a potentially significant change in cases where numerous findspots were involved (e.g. Aylesford, Kent with it's eight HER entries with identical NGRs). On balance, therefore, I decided to accept this limitation of ArcGIS mapping.

Fig. 4.3 Cadastral plan of Sains-en-Amienois, showing location of excavation trenches.



(Photograph © L. Blundell)

Fig. 4.4 Distribution of map projections in Europe

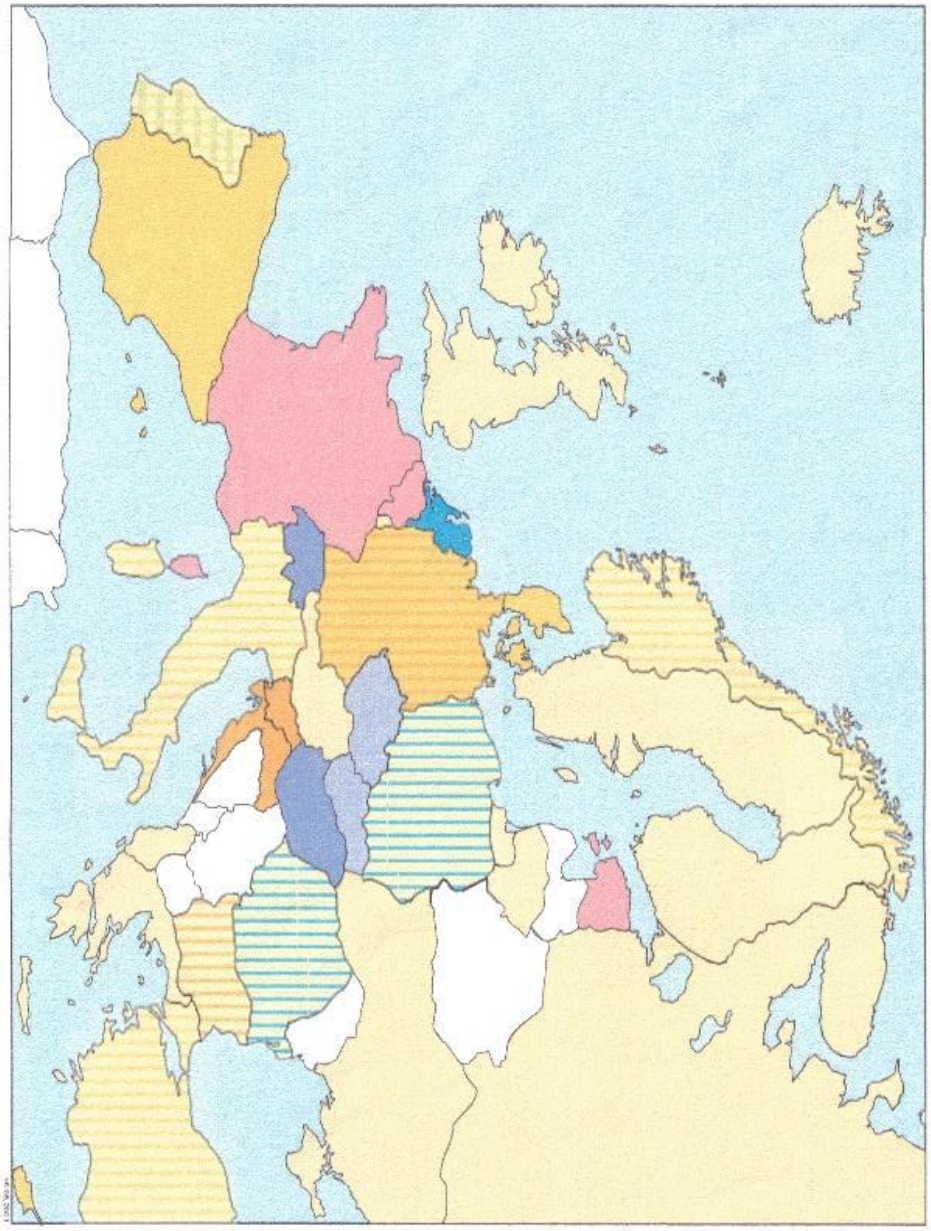


Figure 6:
Distribution of Map Projections in Europe.

© European Commission 2003. *(Reproduced from Anonni et al. 2001 Fig. 6)*

I experienced major difficulties when creating my French geological distribution maps. The Transverse Mercator map projection is used almost universally across Europe, including in Great Britain (Fig 4.4). When paired with a suitable geodetic datum (e.g. the Ordnance Survey datum OSGB36) it delivers high accuracy in geographic regions of less than a few degrees extent from east to west. In France, however, the Lambert Conformal Conic projection is used. Best for regions which are predominantly east-west in extent and located in the middle north or south latitudes, it is also used in Belgium and Estonia. Lambert-93 is currently the official map projection for metropolitan France where, using RGF93 geodetic datum, it is defined by parallels 44°N and 49°N.

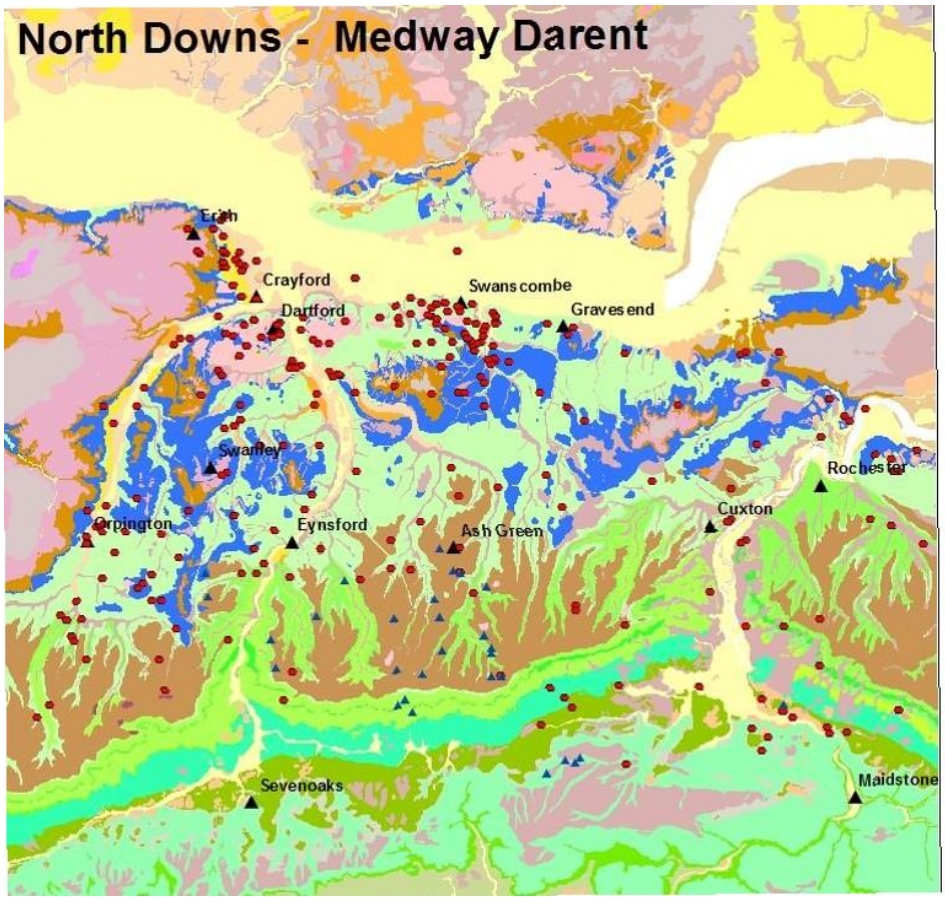
Just as there are no French equivalents to SRPP/TERPP, HERs and the PAS, so there is no French equivalent to the BGS raw data available via Edina Digimap. It was, therefore, impossible to access the digital data of the French geological survey, the Bureau de Recherches Géologiques et Minières (BRGM) for use with ArcGIS. Although the BRGM data, referenced to Lambert 2 étendu or Lambert 93 is available free of charge to French citizens (http://www.brgm.eu/scientific-output/digital-data-services/infoterre-portal-access-to-brgm-geoscientific-data), as a non-French student it would have been necessary for me to purchase it. The purchase price was 1 € per km^2, with a minimum order of at least $200km^2$. At a scale of 1:50,000 (the scale at which my British maps were produced) each sheet covers only $30km^2$ by $20km^2$, with 80 separate maps for the Somme Département alone. The cost of purchasing the data for my geographically large study area would, therefore, have been prohibitive and I was unable to identify a British university with a licence to use the data.

Although not downloadable, the BRGM digital geological maps at scales from 1/1,000,000 to 1/50,000 are freely accessible via the internet using the *Visualiser* facility of *Infoterre* (http://infoterre.brgm.fr/) so I used this to create my French distribution maps. Although *Infoterre* does provide the ability to switch between Lambert 93, Lambert 2 étendu or Latitude and Longitude co-ordinates, there is no facility to use Lambert 1. Neither is it possible to save maps created in the free version of *Infoterre*, nor to print them off. The French maps included in this thesis are, therefore, screenshots saved as jpgs.

It is possible to add individual sites to each French map but these have to be added one at a time rather than adding a whole spreadsheet and all must be added during one online session as maps cannot be saved. Mapping the >120 separate points on the maps therefore required intense concentration. Although each point (site) can be named, these appear not on the map itself (nor, therefore in the screenshot maps), but in a separate list of annotations. It is possible to change the scale of the map while working in *Infoterre* and I created screenshot maps at scales of 1:50,000 and 1:100,000, plus the whole study region at 1:1000,000. (Maps 4.2, 4.3.and 4.4). Unfortunately, the 1:500,000 data (which would have been ideal for displaying regional distributions) was not available.

I was not able to produce a geological map at a scale of 1:1000,000 for the whole of my British study area because the huge volumes of BGS data involved were beyond the handling capacity of the ArcGIS software.

Map 4.1. Example of a findspot distribution map. *Blue triangles represent Benjamin Harrison's sites. Other findspots are in red.*



(Geological Map Data BGS@UKRI 2019). For geology legend see following pages.

Geology Legend

- Towns
- Towns
- Surrey Findspots
- Harrison findspots
- Bell findspots
- Kent findspots

ew288_maidstone_superficial

LEX_RCS_I

ALV-CZPS	*ALLUVIUM - CLAY, SILTY, PEATY, SANDY [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XCZ	*HEAD - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XCZSV	*HEAD - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XVSZC	*HEAD - GRAVEL, SAND, SILT AND CLAY [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XZV	*HEAD - SILT AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD1-XSV	*RIVER TERRACE DEPOSITS, 1 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD2-XSV	*RIVER TERRACE DEPOSITS, 2 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD3-XSV	*RIVER TERRACE DEPOSITS, 3 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD4-XSV	*RIVER TERRACE DEPOSITS, 4 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD5-XSV	*RIVER TERRACE DEPOSITS, 5 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTDU-XCZ	*RIVER TERRACE DEPOSITS (UNDIFFERENTIATED) - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
TUFA-CATUFA	*TUFA - TUFA, CALCAREOUS*
CWF-XCZSV	*CLAY-WITH-FLINTS FORMATION - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*

ew288_maidstone_bedrock

LEX_RCS_I

LNM-SANDU	*LENHAM FORMATION - SAND*
TAB-SSCL	*THANET FORMATION - SAND, SILT AND CLAY*
SECK-CHLK	*SEAFORD CHALK FORMATION - CHALK*
LECH-CHLK	*LEWES NODULAR CHALK FORMATION - CHALK*
NPCH-CHLK	*NEW PIT CHALK FORMATION - CHALK*
HCK-CHLK	*HOLYWELL NODULAR CHALK FORMATION - CHALK*
WMCH-CHLK	*WEST MELBURY MARLY CHALK FORMATION - CHALK*
WZCK-CHLK	*WEST MELBURY MARLY CHALK FORMATION AND ZIG ZAG CHALK FORMATION (UNDIFFERENTIATED) - CHALK*
ZZCH-CHLK	*ZIG ZAG CHALK FORMATION - CHALK*
GLT-MDST	*GAULT FORMATION - MUDSTONE*
AC-STMD	*ATHERFIELD CLAY FORMATION - SANDSTONE AND MUDSTONE*
FO-SDST	*FOLKESTONE FORMATION - SANDSTONE*
HY-SDLM	*HYTHE FORMATION - SANDSTONE AND [SUBEQUAL/SUBORDINATE] LIMESTONE, INTERBEDDED*
SAB-SDSM	*SANDGATE FORMATION - SANDSTONE, SILTSTONE AND MUDSTONE*
WC-LMST	*WEALD CLAY FORMATION - LIMESTONE*
WC-MDST	*WEALD CLAY FORMATION - MUDSTONE*
WC-SDST	*WEALD CLAY FORMATION - SANDSTONE*
TWS-MDST	*TUNBRIDGE WELLS SAND FORMATION - MUDSTONE*
TWS-SDSL	*TUNBRIDGE WELLS SAND FORMATION - SANDSTONE AND SILTSTONE, INTERBEDDED*
WDC-MDST	*WADHURST CLAY FORMATION - MUDSTONE*

ew287_sevenoaks_superficial

LEX_RCS_I

ALV-XCZSV	*ALLUVIUM - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
T1T2-XSV	*RIVER TERRACE DEPOSITS, 1 TO 2 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XCZSV	*HEAD - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD1-XSV	*RIVER TERRACE DEPOSITS, 1 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD2-XSV	*RIVER TERRACE DEPOSITS, 2 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD3-XSV	*RIVER TERRACE DEPOSITS, 3 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD4-XSV	*RIVER TERRACE DEPOSITS, 4 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTDU-XCZ	*RIVER TERRACE DEPOSITS (UNDIFFERENTIATED) - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
CWF-XCZSV	*CLAY-WITH-FLINTS FORMATION - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
DBLB-XSV	*DISTURBED BLACKHEATH BEDS - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*

ew287_sevenoaks_bedrock

LEX_RCS_I

LSNCK-CHLK	*LEWES NODULAR CHALK FORMATION, SEAFORD CHALK FORMATION AND NEWHAVEN CHALK FORMATION (UNDIFFERENTIATED) - CHALK*
NPCH-CHLK	*NEW PIT CHALK FORMATION - CHALK*
GLML-CAMDST	*GLAUCONITIC MARL MEMBER - MUDSTONE, CALCAREOUS*
HNCK-CHLK	*HOLYWELL NODULAR CHALK FORMATION AND NEW PIT CHALK FORMATION (UNDIFFERENTIATED) - CHALK*
MR-CHLK	*MELBOURN ROCK MEMBER - CHALK*
WZCK-CHLK	*WEST MELBURY MARLY CHALK FORMATION AND ZIG ZAG CHALK FORMATION (UNDIFFERENTIATED) - CHALK*
GLT-MDST	*GAULT FORMATION - MUDSTONE*
UGS-SISD	*UPPER GREENSAND FORMATION - SILTSTONE AND SANDSTONE*
AC-MDST	*ATHERFIELD CLAY FORMATION - MUDSTONE*
FO-SDST	*FOLKESTONE FORMATION - SANDSTONE*
HY-SDLM	*HYTHE FORMATION - SANDSTONE AND [SUBEQUAL/SUBORDINATE] LIMESTONE, INTERBEDDED*
SAB-STMD	*SANDGATE FORMATION - SANDSTONE AND MUDSTONE*
WC-LMST	*WEALD CLAY FORMATION - LIMESTONE*
WC-MDST	*WEALD CLAY FORMATION - MUDSTONE*
WC-SDST	*WEALD CLAY FORMATION - SANDSTONE*
ARS-SDST	*ARDINGLY SANDSTONE MEMBER - SANDSTONE*
CKST-CALSST	*CUCKFIELD STONE BED - SANDSTONE, CALCAREOUS*
GRC-MDST	*GRINSTEAD CLAY MEMBER - MUDSTONE*
LGRC-MDST	*LOWER GRINSTEAD CLAY - MUDSTONE*
LTW-SDSL	*LOWER TUNBRIDGE WELLS SAND - SANDSTONE AND SILTSTONE, INTERBEDDED*
LTW-SDSM	*LOWER TUNBRIDGE WELLS SAND - SANDSTONE, SILTSTONE AND MUDSTONE*
TWS-SDSL	*TUNBRIDGE WELLS SAND FORMATION - SANDSTONE AND SILTSTONE, INTERBEDDED*
UGRC-MDST	*UPPER GRINSTEAD CLAY - MUDSTONE*
UTW-SDSL	*UPPER TUNBRIDGE WELLS SAND - SANDSTONE AND SILTSTONE, INTERBEDDED*
WDC-FEST	*WADHURST CLAY FORMATION - IRONSTONE*
WDC-MDST	*WADHURST CLAY FORMATION - MUDSTONE*
ASD-SDSM	*ASHDOWN FORMATION - SANDSTONE, SILTSTONE AND MUDSTONE*

ew272_chatham_superficial

LEX_RCS_I

ALV-CZPS	*ALLUVIUM - CLAY, SILTY, PEATY, SANDY [UNLITHIFIED DEPOSITS CODING SCHEME]*
ALV-XCZSV	*ALLUVIUM - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
ALV-XZC	*ALLUVIUM - SILT AND CLAY [UNLITHIFIED DEPOSITS CODING SCHEME]*
KPGR-XSV	*KEMPTON PARK GRAVEL FORMATION - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
BTFU-XCZS	*BEACH AND TIDAL FLAT DEPOSITS (UNDIFFERENTIATED) - CLAY, SILT AND SAND [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XCZ	*HEAD - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XCZSV	*HEAD - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XVSZC	*HEAD - GRAVEL, SAND, SILT AND CLAY [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XZV	*HEAD - SILT AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD1-XCZ	*RIVER TERRACE DEPOSITS, 1 - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD1-XSV	*RIVER TERRACE DEPOSITS, 1 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD2-XSV	*RIVER TERRACE DEPOSITS, 2 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD3-XSV	*RIVER TERRACE DEPOSITS, 3 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD4-XSV	*RIVER TERRACE DEPOSITS, 4 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTDU-XCZ	*RIVER TERRACE DEPOSITS (UNDIFFERENTIATED) - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
CWF-XCZSV	*CLAY-WITH-FLINTS FORMATION - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*

ew272_chatham_bedrock

LEX_RCS_I

LNM-SAGR	*LENHAM FORMATION - SAND AND GRAVEL*
BGS-SANDU	*BAGSHOT FORMATION - SAND*
CLGB-CLSISA	*CLAYGATE MEMBER - CLAY, SILT AND SAND*
LC-CLSI	*LONDON CLAY FORMATION - CLAY AND SILT*
TAB-SSCL	*THANET FORMATION - SAND, SILT AND CLAY*
HWH-SAGR	*HARWICH FORMATION - SAND AND GRAVEL*
LMBE-SSCL	*LAMBETH GROUP - SAND, SILT AND CLAY*
SECK-CHLK	*SEAFORD CHALK FORMATION - CHALK*
LECH-CHLK	*LEWES NODULAR CHALK FORMATION - CHALK*
LSNCK-CHLK	*LEWES NODULAR CHALK FORMATION, SEAFORD CHALK FORMATION AND NEWHAVEN CHALK FORMATION (UNDIFFERENTIATED) - CHALK*
NPCH-CHLK	*NEW PIT CHALK FORMATION - CHALK*
GLML-CAMDST	*GLAUCONITIC MARL MEMBER - MUDSTONE, CALCAREOUS*
HCK-CHLK	*HOLYWELL NODULAR CHALK FORMATION - CHALK*
HNCK-CHLK	*HOLYWELL NODULAR CHALK FORMATION AND NEW PIT CHALK FORMATION (UNDIFFERENTIATED) - CHALK*
WMCH-CHLK	*WEST MELBURY MARLY CHALK FORMATION - CHALK*
WZCK-CHLK	*WEST MELBURY MARLY CHALK FORMATION AND ZIG ZAG CHALK FORMATION (UNDIFFERENTIATED) - CHALK*
ZZCH-CHLK	*ZIG ZAG CHALK FORMATION - CHALK*
GLT-MDST	*GAULT FORMATION - MUDSTONE*
FO-SDST	*FOLKESTONE FORMATION - SANDSTONE*

ew271_dartford_superficial

LEX_RCS_I

ALV-CZPS	*ALLUVIUM - CLAY, SILTY, PEATY, SANDY [UNLITHIFIED DEPOSITS CODING SCHEME]*
ALV-XCZSV	*ALLUVIUM - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
TRD-XCZ	*TIDAL RIVER OR CREEK DEPOSITS - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
KPGR-XSV	*KEMPTON PARK GRAVEL FORMATION - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
CFSI-XCZ	*CRAYFORD SILT MEMBER - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
HAGR-XSV	*HACKNEY GRAVEL MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
ILSI-XCZ	*ILFORD SILT MEMBER - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
LHGR-XSV	*LYNCH HILL GRAVEL MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
TPGR-XSV	*TAPLOW GRAVEL FORMATION - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
BHT-XSV	*BOYN HILL GRAVEL MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
BPGR-XSV	*BLACK PARK GRAVEL MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
STGR-XSV	*STANMORE GRAVEL FORMATION - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
WHGR-XSV	*WELL HILL GRAVEL FORMATION - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
DASI-XCZ	*DARTFORD SILT MEMBER - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XCZSV	*HEAD - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XVSZC	*HEAD - GRAVEL, SAND, SILT AND CLAY [UNLITHIFIED DEPOSITS CODING SCHEME]*
PEAT-P	*PEAT - PEAT [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTDU-XSV	*RIVER TERRACE DEPOSITS (UNDIFFERENTIATED) - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
CHGR-XSV	*CHELSFIELD GRAVEL FORMATION - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
CWF-XCZSV	*CLAY-WITH-FLINTS FORMATION - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*

ew271_dartford_bedrock

LEX_RCS_I

CLGB-SSCL	*CLAYGATE MEMBER - SAND, SILT AND CLAY*
LC-CLSI	*LONDON CLAY FORMATION - CLAY AND SILT*
TAB-SANDU	*THANET FORMATION - SAND*
HWH-SAGR	*HARWICH FORMATION - SAND AND GRAVEL*
LMBE-SSCL	*LAMBETH GROUP - SAND, SILT AND CLAY*
SNCK-CHLK	*SEAFORD CHALK FORMATION AND NEWHAVEN CHALK FORMATION (UNDIFFERENTIATED) - CHALK*
LECH-CHLK	*LEWES NODULAR CHALK FORMATION - CHALK*
LSNCK-CHLK	*LEWES NODULAR CHALK FORMATION, SEAFORD CHALK FORMATION AND NEWHAVEN CHALK FORMATION (UNDIFFERENTIATED) - CHALK*
NPCH-CHLK	*NEW PIT CHALK FORMATION - CHALK*
HCK-CHLK	*HOLYWELL NODULAR CHALK FORMATION - CHALK*
WZCK-CHLK	*WEST MELBURY MARLY CHALK FORMATION AND ZIG ZAG CHALK FORMATION (UNDIFFERENTIATED) - CHALK*
GLT-MDST	*GAULT FORMATION - MUDSTONE*
FO-SDST	*FOLKESTONE FORMATION - SANDSTONE*

ew258_259_southend_and_foulness_superficial

LEX_RCS_I

ALV-CZPS	*ALLUVIUM - CLAY, SILTY, PEATY, SANDY [UNLITHIFIED DEPOSITS CODING SCHEME]*
ALV-XCZSV	*ALLUVIUM - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
T1T2-XSV	*RIVER TERRACE DEPOSITS, 1 TO 2 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
TFD-XCZ	*TIDAL FLAT DEPOSITS - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
TFD-XSZ	*TIDAL FLAT DEPOSITS - SAND AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
LHGR-XSV	*LYNCH HILL GRAVEL MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
TPGR-XSV	*TAPLOW GRAVEL FORMATION - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
LOFT-DMTN	*LOWESTOFT FORMATION - DIAMICTON*
GFDMP-XSV	*GLACIOFLUVIAL DEPOSITS, MID PLEISTOCENE - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
STGR-XSV	*STANMORE GRAVEL FORMATION - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
BSA-S	*BLOWN SAND - SAND [UNLITHIFIED DEPOSITS CODING SCHEME]*
BTFU-SDSH	*BEACH AND TIDAL FLAT DEPOSITS (UNDIFFERENTIATED) - SEDIMENT, SHELL (SHELLS)*
BTFU-XCZS	*BEACH AND TIDAL FLAT DEPOSITS (UNDIFFERENTIATED) - CLAY, SILT AND SAND [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XCZ	*HEAD - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XCZSV	*HEAD - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
MBD-SDSH	*MARINE BEACH DEPOSITS - SEDIMENT, SHELL (SHELLS)*
RTD1-XCZ	*RIVER TERRACE DEPOSITS, 1 - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD1-XSV	*RIVER TERRACE DEPOSITS, 1 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD2-XCZ	*RIVER TERRACE DEPOSITS, 2 - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD2-XSV	*RIVER TERRACE DEPOSITS, 2 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD3-XCZ	*RIVER TERRACE DEPOSITS, 3 - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD3-XSV	*RIVER TERRACE DEPOSITS, 3 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD4-XSV	*RIVER TERRACE DEPOSITS, 4 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTFD-XCZ	*RAISED TIDAL FLAT DEPOSITS - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
SGAO-XSV	*SAND AND GRAVEL OF UNCERTAIN AGE AND ORIGIN - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
T1T3-XCZ	*RIVER TERRACE DEPOSITS, 1 TO 3 - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
T1T3-XSV	*RIVER TERRACE DEPOSITS, 1 TO 3 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
T2T3-XSV	*RIVER TERRACE DEPOSITS, 2 TO 3 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*

ew258_259_southend_and_foulness_bedrock

LEX_RCS_I

BGS-SANDU	*BAGSHOT FORMATION - SAND*
CLGB-CLSISA	*CLAYGATE MEMBER - CLAY, SILT AND SAND*
LC-CLSISA	*LONDON CLAY FORMATION - CLAY, SILT AND SAND*
TAB-SANDU	*THANET FORMATION - SAND*
HWH-SAGR	*HARWICH FORMATION - SAND AND GRAVEL*
LMBE-CLSISA	*LAMBETH GROUP - CLAY, SILT AND SAND*

ew257_romford_superficial

LEX_RCS_I

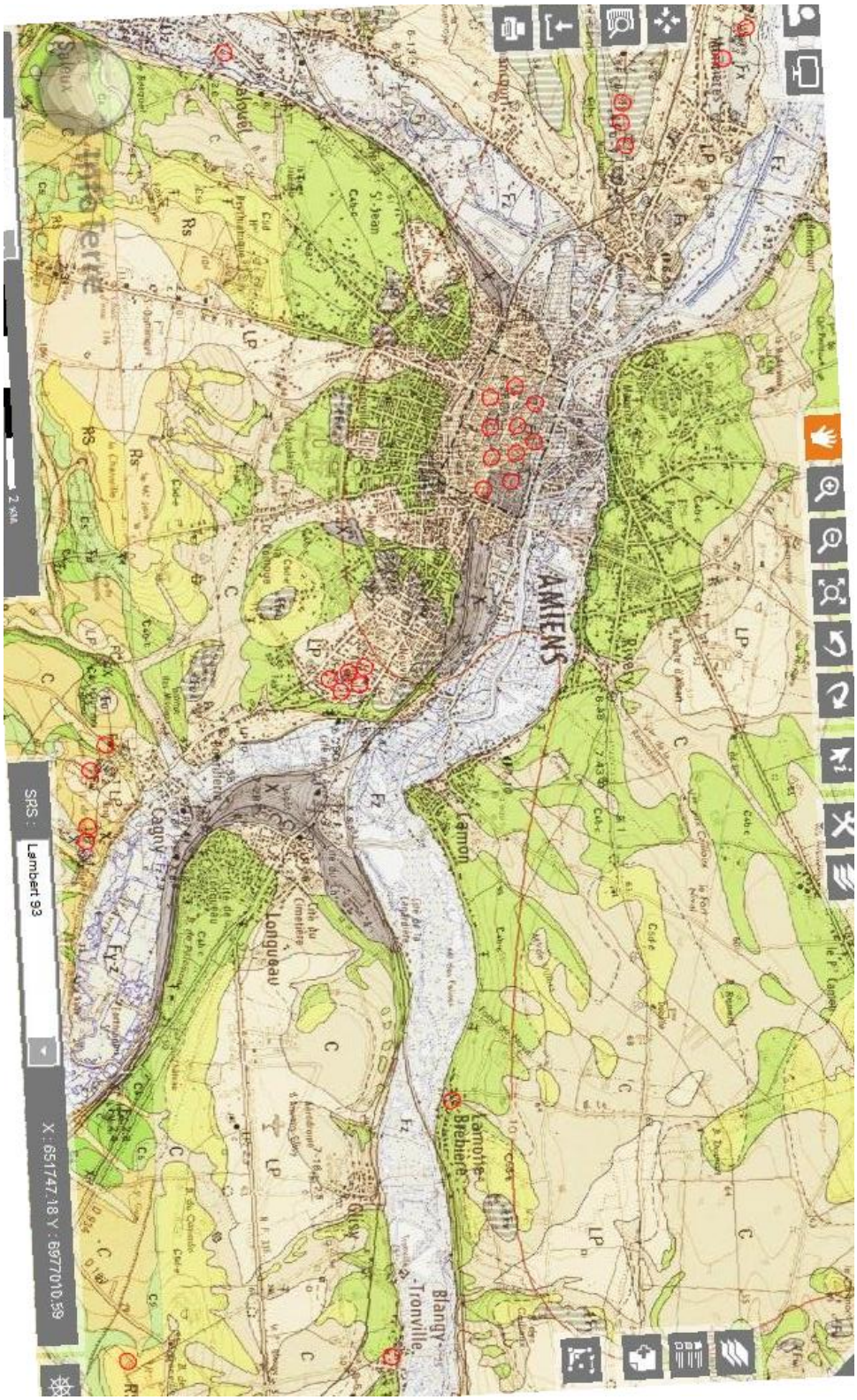
ALV-CZPS	*ALLUVIUM - CLAY, SILTY, PEATY, SANDY [UNLITHIFIED DEPOSITS CODING SCHEME]*
ALV-XCZSV	*ALLUVIUM - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
TRD-XCZ	*TIDAL RIVER OR CREEK DEPOSITS - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
KPGR-XSV	*KEMPTON PARK GRAVEL FORMATION - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
ROSI-XCZ	*RODING SILT MEMBER - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
HAGR-XSV	*HACKNEY GRAVEL MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
ILSI-XCZ	*ILFORD SILT MEMBER - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
LHGR-XSV	*LYNCH HILL GRAVEL MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
TPGR-XSV	*TAPLOW GRAVEL FORMATION - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
BHT-XSV	*BOYN HILL GRAVEL MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
BPGR-XSV	*BLACK PARK GRAVEL MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
LOFT-DMTN	*LOWESTOFT FORMATION - DIAMICTON*
GFDMP-XSV	*GLACIOFLUVIAL DEPOSITS, MID PLEISTOCENE - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
GLLMP-XCZS	*GLACIOLACUSTRINE DEPOSITS, MID PLEISTOCENE - CLAY, SILT AND SAND [UNLITHIFIED DEPOSITS CODING SCHEME]*
WOGR-XSV	*WOODFORD GRAVEL FORMATION - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
STGR-XSV	*STANMORE GRAVEL FORMATION - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XCZSV	*HEAD - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
PEAT-P	*PEAT - PEAT [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTDU-XSV	*RIVER TERRACE DEPOSITS (UNDIFFERENTIATED) - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
SUPD-SED	*SUPERFICIAL DEPOSITS - SEDIMENT*

ew257_romford_bedrock

LEX_RCS_I

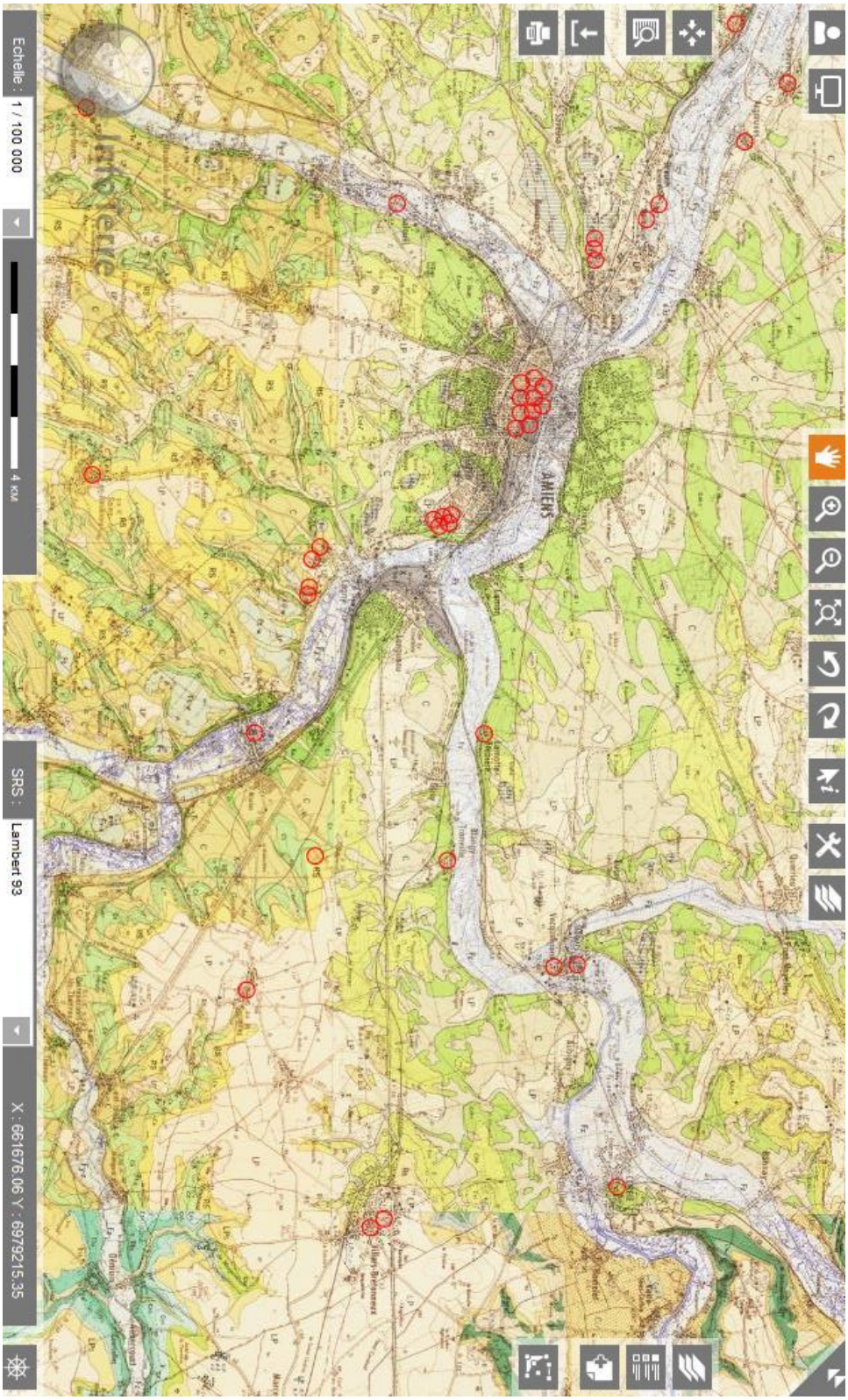
BGS-SANDU	*BAGSHOT FORMATION - SAND*
CLGB-CLSISA	*CLAYGATE MEMBER - CLAY, SILT AND SAND*
CLGB-SANDU	*CLAYGATE MEMBER - SAND*
LC-CLSISA	*LONDON CLAY FORMATION - CLAY, SILT AND SAND*
TAB-SANDU	*THANET FORMATION - SAND*
HWH-SAGR	*HARWICH FORMATION - SAND AND GRAVEL*
LMBE-CLSISA	*LAMBETH GROUP - CLAY, SILT AND SAND*
LSNCK-CHLK	*LEWES NODULAR CHALK FORMATION, SEAFORD CHALK FORMATION AND NEWHAVEN CHALK FORMATION (UNDIFFERENTIATED) - CHALK*

Map 4.2 Distribution map of sites round Amiens (Scale 1:50,000) *Open red circles represent findspots*



(Background map BRGM sheet for Amiens XIII-8. Scale 1:50,000)

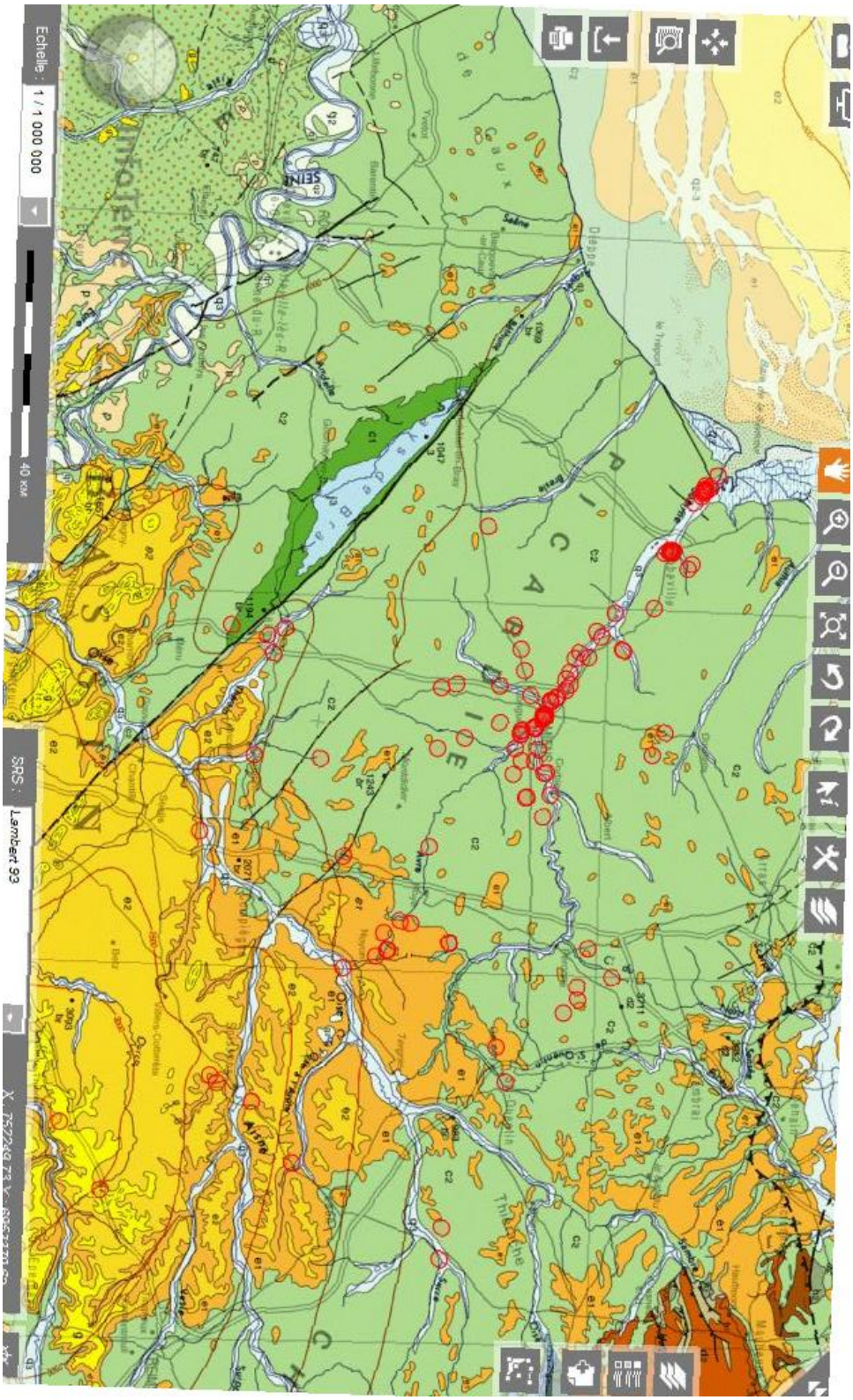
Map 4.3 Distribution map of sites around Amiens (Scale 1:100,000). *Open red circles represent findspots*



(Background map BRGM sheet for Amiens XIII-8. Scale 1:50,000, enhanced to 1:100,000 using Infoterre).

Map 4.4 Distribution map for the whole French study area (scale 1:1000,000).

Open red circles represent findspots



(Background map BRGM data enhanced to 1:1000,000 using Infoterre)

vi) Analysis of the findspot distribution maps.

The Chalk escarpments of the North and South Downs and the Chilterns are breached by a number of river valleys and wind-gaps (seven in the North Downs, five in the South Downs and eight in the Chilterns). I treated each block of land between these breaches in the cuesta as a separate unit for analytical purposes, on a number of grounds. Firstly, watersheds (the obvious alternative demarcation indicators) do not always run from the middle of a land block down into a valley and although the major river systems have remained broadly consistent in their alignments for a least 55Ma (Gibbard and Lewin 2003) some watersheds have moved significantly during and since the Pleistocene. For example, the river Arun in Sussex is encroaching rapidly on the neighbouring basins of the Mole and Wey (Kirkaldy and Bull 1940) while on the North Downs the headwaters and lower reaches of the river Darent have been captured by the Medway, greatly reducing the Darent's significance in the landscape (Bridgland 2003; Prestwich 1891; Treacher 1909).The resolution of ArcGIS mapping and general (G) nature of many findspot map references is not always fine enough to identify definitively which side of a watershed a particular site is located and the antiquarian collectors, whose activities have had a significant effect on the creation of the archaeological record, concentrated their activities on whole interfluves. For example, 'Harrison's plateau' and 'Crawshay's plateau' (Crawshay 1924) respectively east and west of the Darent valley, reflect the collecting activities of Benjamin Harrison and de Barri Crawshay. The same considerations make the arbitrary splitting of very large land-blocks, such as the interfluve between the rivers Medway and Great Stour, unjustifiable. Both geomorphology and history support my choice of river valleys and wind-gaps to demarcate my landscape units.

I measured the approximate area of each Chalk land-block in square kilometres (km^2) using the ArcGIS measuring tool. In each case the measurement was taken down the middle of the river valley or wind gap and the results entered, in $100km^2$, into an Excel spreadsheet. For this purpose a map scale of 1:250,000 was considered adequate (Fig. 4.5).

On the western South Downs it was not immediately clear how to delimit the Chalk land-blocks defined by the Rivers Test, Itchen, Meon and Ems. I

decided to follow each of these river valleys north to the point at which it swings east to head to its source, then to follow eastwards to that source before dropping down to re-enter the next river valley to the east and so back to the coastal plain.

I likewise measured the areas mapped as Clay-with-flints superficial deposits by the BGS (hereafter referred to as Clay-with-flints) for each land-block, entered it into the Excel spreadsheet and calculated it as a percentage of the Chalk bedrock. I also measured any outlying fragments of Clay-with-flints and included them in the total. For reasons of clarity I used a map scale of 1:100,000 for this purpose.

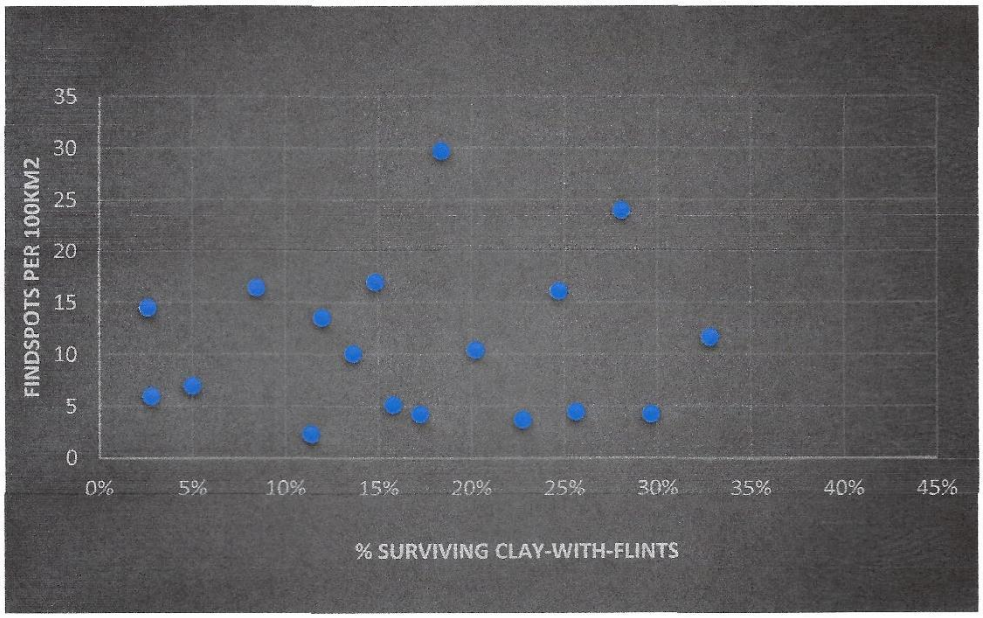
ArcGIS allows the measurement of areas of geological deposit by selecting polygons and drawing a box around them. Measurement can be in acres, hectares or square kilometres, as used in my calculations. However, although measurement of polygons works for the superficial deposits, the BGS polygons of Chalk bedrock do not coincide with the individual interfluves I have used as my units of analysis for this research. It is, however, still possible to measure the Chalk bedrock relating to each interfluve by drawing around them using the same river valleys or wind gaps as demarcation zones. The results obtained using this method are sufficiently accurate for analysis on the landscape scale required for my research.

I counted the number of sites lying on the Chalk and/or Clay-with-flints of each land-block and entered them into an Excel spreadsheet, allowing me to calculate the number of such findspots per 100 km^2 for each interfluve. I also counted sites on Head deposits lying below each interfluve, as these were potentially eroded from the plateau above. For example, there are 22 findspots on deposits mapped as Head relating to the Medway-Darent interfluve (Fig. 4.1). Sites on other superficial deposits were omitted from consideration. I used a map scale of 1:100,000 for counting/assigning all the findspots to their geological context.

Using a map scale of 1:80,000 I then assessed by eye the locations of findspots in relation to the edges of the Clay-with-flints for each study area to test whether most findspots lay along the erosional edge of the deposit. This would be consistent with my working hypothesis.

I created scatter diagrams to identify any relationship between findspot density and geology, particularly the survival of Clay-with-flints superficial deposits (Fig. 4.5). Apparent anomalies like the spike in finds visible at 19% were considered in the light of possible distorting effects on the creation of the archaeological record. These were collector history, historic land-use, industrial and infrastructure history or the presence of 'super sites' such as Swanscombe, responsible for 22 findspots on the dip-slope of the Medway-Darent interfluve because of cumulative collector bias by multiple collectors.

Fig. 4.5 Example of a scatter diagram



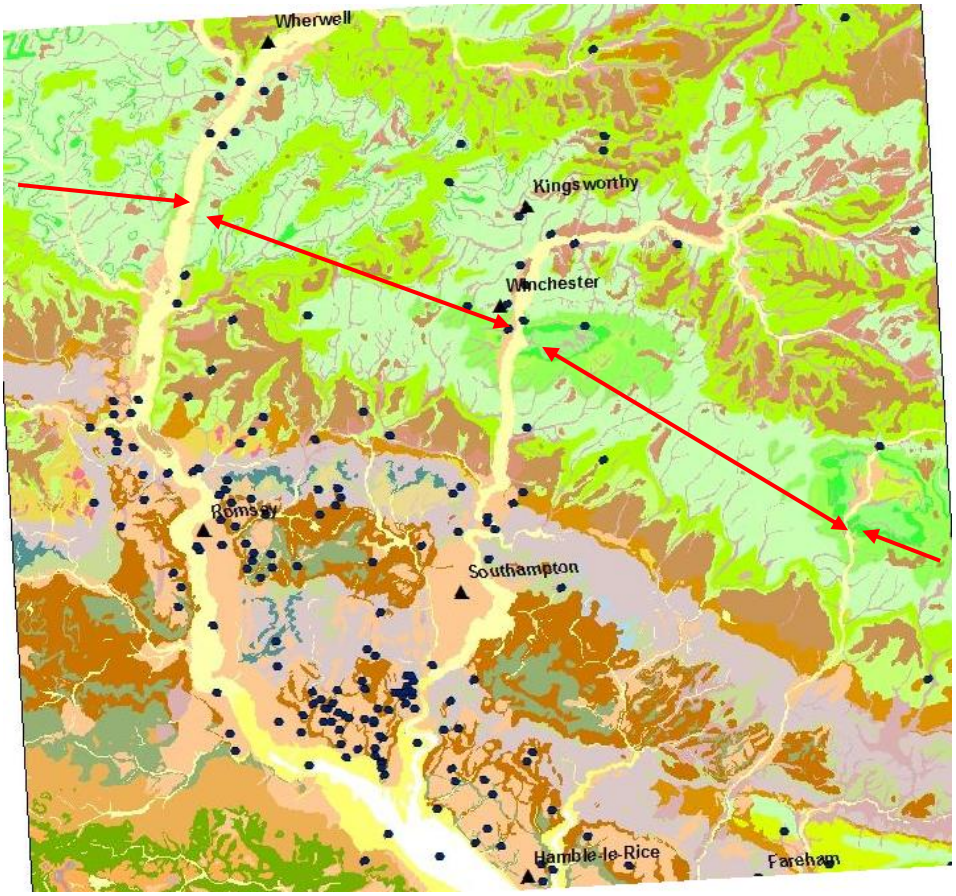
It was not possible to carry out the same detailed analysis of the French geological maps as I was not working with the digital raw data. However, the deep loess deposits covering much of the study area meant that the mapping to specific superficial deposits I carried out for my English sites would have had little meaning in France, where sites are more usually found not on the surface but deeply buried under the loess and Clay-with-flints survival/absence is not the dominant factor in artefact preservation or release.

Issues encountered in analysing the distribution maps

Some BGS maps were surveyed in the 19th and early 20th centuries on the old six inch scale using now-obsolete terminology and colour schemes for the geological deposits. These maps have since either been metricated to

1:50,000 and republished, or simply photographically enlarged and reprinted without revision. The Edina Digimap geological downloads generally use modern terminology, with greater differentiation of the bedrock and different colouring for the same geological deposits. For example, on the hard-copy Sheet 238 (Aylesbury) last surveyed in 1912, no differentiation is made between Upper Greensand and Gault, whereas the digital mapping shows clearly that there is virtually no Upper Greensand in the Chilterns north of Princes Risborough. These differences proved particularly problematic in the North Chilterns, where several map sheets of significantly different dates, and therefore significantly different representations of the same geological deposits overlap and the differences have been replicated in the digital mapping (Fig. 4.7). Another example occurs in the Hampshire Chalklands, between Sheets 284 (Basingstoke) and 283 (Andover).

Fig. 4.6. Example of the demaraction of interfluves, between the rivers Test, Itchen and Meon, South Downs. *The extent of each interfluve is demarcated by a red arrow.Blue circles represent findspots.*



(Geological Map Data BGS ©UKRI 2019). For geology legend see following pages.

Geology Legend

- Findspots
- Findspots
- ▲ Towns
- ▲ Towns

ew316_fareham_superficial

LEX_RCS_I

ALV-XCZSV	*ALLUVIUM - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
TFD-XCZ	*TIDAL FLAT DEPOSITS - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
RS1-XSV	*SUSSEX ROTHER TERRACE DEPOSITS, 1 MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RS2-XSV	*SUSSEX ROTHER TERRACE DEPOSITS, 2 MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RS3-XSV	*SUSSEX ROTHER TERRACE DEPOSITS, 3 MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
ALF-XCZSV	*ALLUVIAL FAN DEPOSITS - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
BSA1-S	*BLOWN SAND, 1 - SAND [UNLITHIFIED DEPOSITS CODING SCHEME]*
BTFU-XCZSV	*BEACH AND TIDAL FLAT DEPOSITS (UNDIFFERENTIATED) - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-VC	*HEAD - GRAVEL, CLAYEY [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XCZSV	*HEAD - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD1-XCZSV	*HEAD, 1 - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
PEAT-P	*PEAT - PEAT [UNLITHIFIED DEPOSITS CODING SCHEME]*
RBD1-XSV	*RAISED BEACH DEPOSITS, 1 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RMD-XSV	*RAISED MARINE DEPOSITS - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RSB2-V	*RAISED STORM BEACH DEPOSITS, 2 - GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD1-XSV	*RIVER TERRACE DEPOSITS, 1 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD1-XVSZ	*RIVER TERRACE DEPOSITS, 1 - GRAVEL, SAND AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD2-XCZ	*RIVER TERRACE DEPOSITS, 2 - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD2-XSV	*RIVER TERRACE DEPOSITS, 2 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD2-XVSZ	*RIVER TERRACE DEPOSITS, 2 - GRAVEL, SAND AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD3-XSV	*RIVER TERRACE DEPOSITS, 3 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD3-XVSZ	*RIVER TERRACE DEPOSITS, 3 - GRAVEL, SAND AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD4-XSV	*RIVER TERRACE DEPOSITS, 4 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD4-XVSZ	*RIVER TERRACE DEPOSITS, 4 - GRAVEL, SAND AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD5-XSV	*RIVER TERRACE DEPOSITS, 5 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD5-XVSZ	*RIVER TERRACE DEPOSITS, 5 - GRAVEL, SAND AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD6-XSV	*RIVER TERRACE DEPOSITS, 6 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD6-XVSZ	*RIVER TERRACE DEPOSITS, 6 - GRAVEL, SAND AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD7-XVSZ	*RIVER TERRACE DEPOSITS, 7 - GRAVEL, SAND AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTDU-XSV	*RIVER TERRACE DEPOSITS (UNDIFFERENTIATED) - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTDU-XSZC	*RIVER TERRACE DEPOSITS (UNDIFFERENTIATED) - SAND, SILT AND CLAY [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTDU-XVSZ	*RIVER TERRACE DEPOSITS (UNDIFFERENTIATED) - GRAVEL, SAND AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
T4T6-XVSZ	*RIVER TERRACE DEPOSITS, 4 TO 6 - GRAVEL, SAND AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
T6T7-XVSZ	*RIVER TERRACE DEPOSITS, 6 TO 7 - GRAVEL, SAND AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
CWF-XCZSV	*CLAY-WITH-FLINTS FORMATION - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*

ew316_fareham_bedrock

LEX_RCS_I

EA-SSCL	*EARNLEY SAND FORMATION - SAND, SILT AND CLAY*
MARF-CLSISA	*MARSH FARM FORMATION - CLAY, SILT AND SAND*
SLSY-SSCL	*SELSEY SAND FORMATION - SAND, SILT AND CLAY*
WTT-SANDU	*WITTERING FORMATION - SAND*
WTT-SSCL	*WITTERING FORMATION - SAND, SILT AND CLAY*
BOSA-SANDU	*BOGNOR SAND MEMBER - SAND*
DYSA-SANDU	*DURLEY SAND MEMBER - SAND*
LC-CLSISA	*LONDON CLAY FORMATION - CLAY, SILT AND SAND*
LC-SANDU	*LONDON CLAY FORMATION - SAND*
LMBE-CLSISA	*LAMBETH GROUP - CLAY, SILT AND SAND*
LMBE-SANDU	*LAMBETH GROUP - SAND*
PORT-SANDU	*PORTSMOUTH SAND MEMBER - SAND*
POWH-SANDU	*PORTSMOUTH SAND MEMBER AND WHITECLIFF SAND MEMBER (UNDIFFERENTIATED) - SAND*
WHI-SANDU	*WHITECLIFF SAND MEMBER - SAND*
PCK-CHLK	*PORTSDOWN CHALK FORMATION - CHALK*
SPCH-CHLK	*SPETISBURY CHALK MEMBER - CHALK*
TACH-CHLK	*TARRANT CHALK MEMBER - CHALK*
NCK-CHLK	*NEWHAVEN CHALK FORMATION - CHALK*
SECK-CHLK	*SEAFORD CHALK FORMATION - CHALK*
LECH-CHLK	*LEWES NODULAR CHALK FORMATION - CHALK*
LPCK-CHLK	*LEWES NODULAR CHALK FORMATION, SEAFORD CHALK FORMATION, NEWHAVEN CHALK FORMATION, CULVER CHALK FORMATION AND PORTSDOWI*
NPCH-CHLK	*NEW PIT CHALK FORMATION - CHALK*
GLML-GLSST	*GLAUCONITIC MARL MEMBER - SANDSTONE, GLAUCONITIC*
HCK-CHLK	*HOLYWELL NODULAR CHALK FORMATION - CHALK*
WMCH-CHLK	*WEST MELBURY MARLY CHALK FORMATION - CHALK*
ZZCH-CHLK	*ZIG ZAG CHALK FORMATION - CHALK*
GLT-MDST	*GAULT FORMATION - MUDSTONE*
UGS-CSSL	*UPPER GREENSAND FORMATION - CALCAREOUS SANDSTONE AND SILTSTONE*
FO-SDST	*FOLKESTONE FORMATION - SANDSTONE*
MHCL-MDST	*LOWER MAREHILL CLAY - MUDSTONE*
MHCU-MDST	*UPPER MAREHILL CLAY - MUDSTONE*
PBSU-SDST	*UPPER PULBOROUGH SANDROCK - SANDSTONE*

ew315_southampton_superficial

LEX_RCS_I

ALV-XCZSV	*ALLUVIUM - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
T3T4-XSV	*RIVER TERRACE DEPOSITS, 3 TO 4 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
TFD-XCZ	*TIDAL FLAT DEPOSITS - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
CFD-V	*CHANNEL-FILL DEPOSITS - GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-CZ	*HEAD - CLAY, SILTY [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XCZSV	*HEAD - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XVSZC	*HEAD - GRAVEL, SAND, SILT AND CLAY [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD1-XCZSV	*HEAD, 1 - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
PEAT-P	*PEAT - PEAT [UNLITHIFIED DEPOSITS CODING SCHEME]*
RT11-XSV	*RIVER TERRACE DEPOSITS, 11 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD1-XCZ	*RIVER TERRACE DEPOSITS, 1 - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD1-XSV	*RIVER TERRACE DEPOSITS, 1 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD2-XSV	*RIVER TERRACE DEPOSITS, 2 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD3-XCZ	*RIVER TERRACE DEPOSITS, 3 - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD3-XSV	*RIVER TERRACE DEPOSITS, 3 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD4-XCZ	*RIVER TERRACE DEPOSITS, 4 - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD4-XSV	*RIVER TERRACE DEPOSITS, 4 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD5-XSV	*RIVER TERRACE DEPOSITS, 5 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD6-XSV	*RIVER TERRACE DEPOSITS, 6 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD7-XSV	*RIVER TERRACE DEPOSITS, 7 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD8-XSV	*RIVER TERRACE DEPOSITS, 8 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD9-XSV	*RIVER TERRACE DEPOSITS, 9 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTDU-XCZ	*RIVER TERRACE DEPOSITS (UNDIFFERENTIATED) - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTDU-XSV	*RIVER TERRACE DEPOSITS (UNDIFFERENTIATED) - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTDX-XSV	*RIVER TERRACE DEPOSITS, 10 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
T2T3-XSV	*RIVER TERRACE DEPOSITS, 2 TO 3 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
T4T5-XSV	*RIVER TERRACE DEPOSITS, 4 TO 5 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
T5T6-XSV	*RIVER TERRACE DEPOSITS, 5 TO 6 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
T6T7-XSV	*RIVER TERRACE DEPOSITS, 6 TO 7 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
TUFA-CATUFA	*TUFA - TUFA, CALCAREOUS*
CWF-XCZSV	*CLAY-WITH-FLINTS FORMATION - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*

ew315_southampton_bedrock

LEX_RCS_I

BECS-SANDU	*BECTON SAND FORMATION - SAND*
CHMS-SSCL	*CHAMA SAND FORMATION - SAND, SILT AND CLAY*
HE-CLSISA	*HEADON FORMATION - CLAY, SILT AND SAND*
BAC-CLAY	*BARTON CLAY FORMATION - CLAY*
BAC-SANDU	*BARTON CLAY FORMATION - SAND*
EA-SSCL	*EARNLEY SAND FORMATION - SAND, SILT AND CLAY*
MARF-CLSISA	*MARSH FARM FORMATION - CLAY, SILT AND SAND*
SLSY-SSCL	*SELSEY SAND FORMATION - SAND, SILT AND CLAY*
WTT-SSCL	*WITTERING FORMATION - SAND, SILT AND CLAY*
BOSA-SANDU	*BOGNOR SAND MEMBER - SAND*
DYSA-SANDU	*DURLEY SAND MEMBER - SAND*
LC-CLSISA	*LONDON CLAY FORMATION - CLAY, SILT AND SAND*
LC-SANDU	*LONDON CLAY FORMATION - SAND*
LMBE-CLSISA	*LAMBETH GROUP - CLAY, SILT AND SAND*
LMBE-SANDU	*LAMBETH GROUP - SAND*
LMBE-SV	*LAMBETH GROUP - SAND, GRAVELLY [UNLITHIFIED DEPOSITS CODING SCHEME]*
RB-SANDU	*READING FORMATION - SAND*
BECB-CLAY	*BECTON BUNNY MEMBER - CLAY*
LY-SSCL	*LYNDHURST MEMBER - SAND, SILT AND CLAY*
NU-CLSISA	*NURSLING SAND MEMBER - CLAY, SILT AND SAND*
PORT-SANDU	*PORTSMOUTH SAND MEMBER - SAND*
POWH-SANDU	*PORTSMOUTH SAND MEMBER AND WHITECLIFF SAND MEMBER (UNDIFFERENTIATED) - SAND*
WHI-SANDU	*WHITECLIFF SAND MEMBER - SAND*
WHI-SV	*WHITECLIFF SAND MEMBER - SAND, GRAVELLY [UNLITHIFIED DEPOSITS CODING SCHEME]*
CUCK-CHLK	*CULVER CHALK FORMATION - CHALK*
PCK-CHLK	*PORTSDOWN CHALK FORMATION - CHALK*
TACH-CHLK	*TARRANT CHALK MEMBER - CHALK*
NCK-CHLK	*NEWHAVEN CHALK FORMATION - CHALK*

ew300_alresford_superficial

LEX_RCS_I

ALV-XCZSV	*ALLUVIUM - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RS1A-XSV	*SUSSEX ROTHER TERRACE DEPOSITS, FACET 1A - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RS1B-XSV	*SUSSEX ROTHER TERRACE DEPOSITS, FACET 1B - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RS2-XVSZ	*SUSSEX ROTHER TERRACE DEPOSITS, 2 MEMBER - GRAVEL, SAND AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
RS3-XSV	*SUSSEX ROTHER TERRACE DEPOSITS, 3 MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RS4-XSV	*SUSSEX ROTHER TERRACE DEPOSITS, 4 MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RS5-XSV	*SUSSEX ROTHER TERRACE DEPOSITS, 5 MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
BSA1-S	*BLOWN SAND, 1 - SAND [UNLITHIFIED DEPOSITS CODING SCHEME]*
GW1-XSV	*RIVER TERRACE DEPOSITS, 1 (GODALMING WEY) - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
GW1A-XSV	*RIVER TERRACE DEPOSITS, 1A (GODOLMING WEY) - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
GW1B-XSV	*RIVER TERRACE DEPOSITS, 1B (GODALMING WEY) - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
GW2-XSV	*RIVER TERRACE DEPOSITS, 2 (GODALMING WEY) - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
GW3-XSV	*RIVER TERRACE DEPOSITS, 3 (GODALMING WEY) - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XCZSV	*HEAD - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XVSZC	*HEAD - GRAVEL, SAND, SILT AND CLAY [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD1-XCZSV	*HEAD, 1 - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD2-XCZSV	*HEAD, 2 - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
PEAT-P	*PEAT - PEAT [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD1-XSV	*RIVER TERRACE DEPOSITS, 1 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD2-XSV	*RIVER TERRACE DEPOSITS, 2 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD3-XSV	*RIVER TERRACE DEPOSITS, 3 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD4-XSV	*RIVER TERRACE DEPOSITS, 4 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD5-XSV	*RIVER TERRACE DEPOSITS, 5 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTDU-XSV	*RIVER TERRACE DEPOSITS (UNDIFFERENTIATED) - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
CWF-XCZSV	*CLAY-WITH-FLINTS FORMATION - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*

ew300_alresford_bedrock

LEX_RCS_I

LMBE-CLSISA	*LAMBETH GROUP - CLAY, SILT AND SAND*
TACH-CHLK	*TARRANT CHALK MEMBER - CHALK*
NCK-CHLK	*NEWHAVEN CHALK FORMATION - CHALK*
SECK-CHLK	*SEAFORD CHALK FORMATION - CHALK*
LECH-CHLK	*LEWES NODULAR CHALK FORMATION - CHALK*
NPCH-CHLK	*NEW PIT CHALK FORMATION - CHALK*
GLML-GLSST	*GLAUCONITIC MARL MEMBER - SANDSTONE, GLAUCONITIC*
HCK-CHLK	*HOLYWELL NODULAR CHALK FORMATION - CHALK*
WMCH-CHLK	*WEST MELBURY MARLY CHALK FORMATION - CHALK*
ZZCH-CHLK	*ZIG ZAG CHALK FORMATION - CHALK*
GLT-MDST	*GAULT FORMATION - MUDSTONE*
UGS-CSSL	*UPPER GREENSAND FORMATION - CALCAREOUS SANDSTONE AND SILTSTONE*
AC-MDST	*ATHERFIELD CLAY FORMATION - MUDSTONE*
BT-SDST	*BARGATE SANDSTONE MEMBER - SANDSTONE*
FO-SDST	*FOLKESTONE FORMATION - SANDSTONE*
HY-SDST	*HYTHE FORMATION - SANDSTONE*
MHC-MDST	*MAREHILL CLAY MEMBER - MUDSTONE*
MHCL-MDST	*LOWER MAREHILL CLAY - MUDSTONE*
MHCU-MDST	*UPPER MAREHILL CLAY - MUDSTONE*
PBS-SDST	*PULBOROUGH SANDROCK MEMBER - SANDSTONE*
PBSL-SDST	*LOWER PULBOROUGH SANDROCK - SANDSTONE*
PBSU-SDST	*UPPER PULBOROUGH SANDROCK - SANDSTONE*
RGTB-MDST	*ROGATE MEMBER - MUDSTONE*
RGTB-PESST	*ROGATE MEMBER - SANDSTONE, PEBBLY (GRAVELLY)*
SAB-SDSM	*SANDGATE FORMATION - SANDSTONE, SILTSTONE AND MUDSTONE*
WC-FESTC	*WEALD CLAY FORMATION - CLAY-IRONSTONE*
WC-MDST	*WEALD CLAY FORMATION - MUDSTONE*
WC-SDST	*WEALD CLAY FORMATION - SANDSTONE*

ew299_winchester_superficial

LEX_RCS_I

ALV-XCZSV	*ALLUVIUM - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
T2T4-XSV	*RIVER TERRACE DEPOSITS, 2 TO 4 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD1A-XSV	*RIVER TERRACE DEPOSITS, 1A - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD1B-XSV	*RIVER TERRACE DEPOSITS, 1B - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XCZSV	*HEAD - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XVSZC	*HEAD - GRAVEL, SAND, SILT AND CLAY [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD1-XCZSV	*HEAD, 1 - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
PEAT-P	*PEAT - PEAT [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD1-XSV	*RIVER TERRACE DEPOSITS, 1 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD2-XSV	*RIVER TERRACE DEPOSITS, 2 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD3-XSV	*RIVER TERRACE DEPOSITS, 3 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD4-XSV	*RIVER TERRACE DEPOSITS, 4 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD5-XSV	*RIVER TERRACE DEPOSITS, 5 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD7-XSV	*RIVER TERRACE DEPOSITS, 7 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD8-XSV	*RIVER TERRACE DEPOSITS, 8 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTDU-XCZ	*RIVER TERRACE DEPOSITS (UNDIFFERENTIATED) - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTDU-XSV	*RIVER TERRACE DEPOSITS (UNDIFFERENTIATED) - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
T2T3-XSV	*RIVER TERRACE DEPOSITS, 2 TO 3 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
T5T6-XSV	*RIVER TERRACE DEPOSITS, 5 TO 6 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
TUFA-CATUFA	*TUFA - TUFA, CALCAREOUS*
CWF-XCZSV	*CLAY-WITH-FLINTS FORMATION - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*

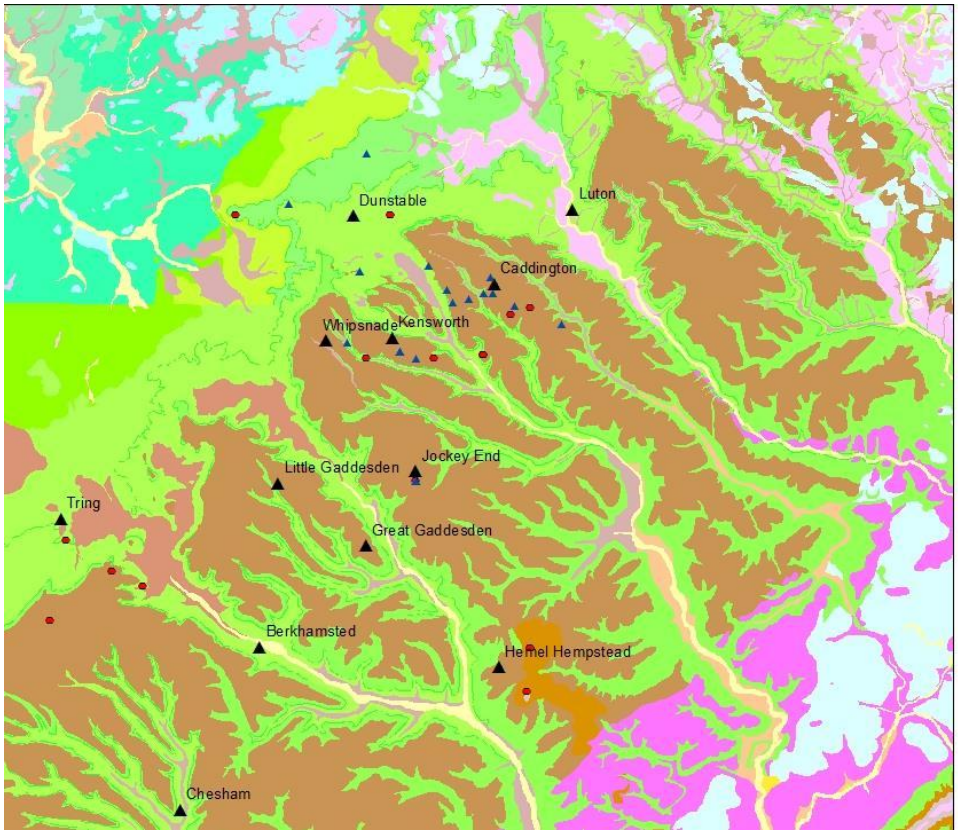
ew299_winchester_bedrock

LEX_RCS_I

	WTT-SSCL	*WITTERING FORMATION - SAND, SILT AND CLAY*
	LC-CLSISA	*LONDON CLAY FORMATION - CLAY, SILT AND SAND*
	LMBE-CLSISA	*LAMBETH GROUP - CLAY, SILT AND SAND*
	LMBE-SANDU	*LAMBETH GROUP - SAND*
	LMBE-SV	*LAMBETH GROUP - SAND, GRAVELLY [UNLITHIFIED DEPOSITS CODING SCHEME]*
	RB-SANCL	*READING FORMATION - SAND AND CLAY*
	RB-SANDU	*READING FORMATION - SAND*
	NU-CLSISA	*NURSLING SAND MEMBER - CLAY, SILT AND SAND*
	WHI-SANDU	*WHITECLIFF SAND MEMBER - SAND*
	WHI-SV	*WHITECLIFF SAND MEMBER - SAND, GRAVELLY [UNLITHIFIED DEPOSITS CODING SCHEME]*
	CUCK-CHLK	*CULVER CHALK FORMATION - CHALK*
	PCK-CHLK	*PORTSDOWN CHALK FORMATION - CHALK*
	SPCH-CHLK	*SPETISBURY CHALK MEMBER - CHALK*
	TACH-CHLK	*TARRANT CHALK MEMBER - CHALK*
	NCK-CHLK	*NEWHAVEN CHALK FORMATION - CHALK*
	STRK-LMST	*STOCKBRIDGE ROCK MEMBER - LIMESTONE*
	SECK-CHLK	*SEAFORD CHALK FORMATION - CHALK*
	LECH-CHLK	*LEWES NODULAR CHALK FORMATION - CHALK*
	NPCH-CHLK	*NEW PIT CHALK FORMATION - CHALK*
	HCK-CHLK	*HOLYWELL NODULAR CHALK FORMATION - CHALK*
	ZZCH-CHLK	*ZIG ZAG CHALK FORMATION - CHALK*

Fig. 4.7. Example of disjunction in geological mapping on the North Chilterns between Dunstable and Tring.

Showing the disjunction in the geological mapping between Sheets 220 (Leighton Buzzard) and 238 (Aylesbury). Blue triangles represent Worthington Smith's sites. Other sites are shown in red.



(Geological Map Data BGS©UKRI 2019). For geology legend see following pages.

Geology Legend

- Smith findspots
- Findspots
- ▲ Towns

ew239_hertford_superficial

LEX_RCS_I

ALV-XCZSV	*ALLUVIUM - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
ESI-XCZ	*ENFIELD SILT MEMBER - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
KPGR-XCZ	*KEMPTON PARK GRAVEL FORMATION - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
KPGR-XSV	*KEMPTON PARK GRAVEL FORMATION - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
TPGR-XSV	*TAPLOW GRAVEL FORMATION - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
LOFT-DMTN	*LOWESTOFT FORMATION - DIAMICTON*
WIHG-XSV	*WINTER HILL GRAVEL - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
DHGR-XSV	*DOLLIS HILL GRAVEL MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
GCGR-XSV	*GERRARDS CROSS GRAVEL - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
GFDMP-XSV	*GLACIOFLUVIAL DEPOSITS, MID PLEISTOCENE - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
GLLMP-XCZ	*GLACIOLACUSTRINE DEPOSITS, MID PLEISTOCENE - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
KGCA-XSV	*KESGRAVE CATCHMENT SUBGROUP - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
STGR-XSV	*STANMORE GRAVEL FORMATION - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XCZSV	*HEAD - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XVSZC	*HEAD - GRAVEL, SAND, SILT AND CLAY [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTDU-XSV	*RIVER TERRACE DEPOSITS (UNDIFFERENTIATED) - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
SGAO-XSV	*SAND AND GRAVEL OF UNCERTAIN AGE AND ORIGIN - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
CWF-XCZSV	*CLAY-WITH-FLINTS FORMATION - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*

ew238_aylesbury_superficial

LEX_RCS_I

ALV-XCZSV	*ALLUVIUM - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
LOFT-DMTN	*LOWESTOFT FORMATION - DIAMICTON*
GCGR-XSV	*GERRARDS CROSS GRAVEL - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
GFDMP-XSV	*GLACIOFLUVIAL DEPOSITS, MID PLEISTOCENE - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
CWGR-XSV	*CHORLEYWOOD GRAVEL FORMATION - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
KGCA-XSV	*KESGRAVE CATCHMENT SUBGROUP - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
PRSG-XSV	*PRINCES RISBOROUGH SAND AND GRAVEL - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-V	*HEAD - GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XCZ	*HEAD - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XCZSV	*HEAD - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD1-XCZSV	*HEAD, 1 - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD1-XSV	*RIVER TERRACE DEPOSITS, 1 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD2-XSV	*RIVER TERRACE DEPOSITS, 2 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTDU-XSV	*RIVER TERRACE DEPOSITS (UNDIFFERENTIATED) - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
CWF-XCZSV	*CLAY-WITH-FLINTS FORMATION - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*

ew238_aylesbury_bedrock

LEX_RCS_I

LC-CLSISA	*LONDON CLAY FORMATION - CLAY, SILT AND SAND*
LMBE-CLSISA	*LAMBETH GROUP - CLAY, SILT AND SAND*
CKR-CHLK	*CHALK ROCK MEMBER - CHALK*
LECH-CHLK	*LEWES NODULAR CHALK FORMATION - CHALK*
LESE-CHLK	*LEWES NODULAR CHALK FORMATION AND SEAFORD CHALK FORMATION (UNDIFFERENTIATED) - CHALK*
NPCH-CHLK	*NEW PIT CHALK FORMATION - CHALK*
GLML-GLSST	*GLAUCONITIC MARL MEMBER - SANDSTONE, GLAUCONITIC*
HNCK-CHLK	*HOLYWELL NODULAR CHALK FORMATION AND NEW PIT CHALK FORMATION (UNDIFFERENTIATED) - CHALK*
MR-CHLK	*MELBOURN ROCK MEMBER - CHALK*
WZCK-CHLK	*WEST MELBURY MARLY CHALK FORMATION AND ZIG ZAG CHALK FORMATION (UNDIFFERENTIATED) - CHALK*
ZZCH-CHLK	*ZIG ZAG CHALK FORMATION - CHALK*
GLT-MDST	*GAULT FORMATION - MUDSTONE*
GUGS-MDSS	*GAULT FORMATION AND UPPER GREENSAND FORMATION (UNDIFFERENTIATED) - MUDSTONE, SILTSTONE AND SANDSTONE*
UGS-SISD	*UPPER GREENSAND FORMATION - SILTSTONE AND SANDSTONE*
PB-LMAR	*PURBECK GROUP - LIMESTONE AND [SUBEQUAL/SUBORDINATE] ARGILLACEOUS ROCKS, INTERBEDDED*
PL-LMCS	*PORTLAND GROUP - LIMESTONE AND CALCAREOUS SANDSTONE*
POSA-LMCS	*PORTLAND SAND FORMATION - LIMESTONE AND CALCAREOUS SANDSTONE*
POST-LMST	*PORTLAND STONE FORMATION - LIMESTONE*
KC-MDST	*KIMMERIDGE CLAY FORMATION - MUDSTONE*

ew220_leighton_buzzard_superficial

LEX_RCS_I

ALV-XCZSV	*ALLUVIUM - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
T1T2-XSV	*RIVER TERRACE DEPOSITS, 1 TO 2 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
LOFT-DMTN	*LOWESTOFT FORMATION - DIAMICTON*
ODT-DMTN	*OADBY MEMBER - DIAMICTON*
GFDMP-XSV	*GLACIOFLUVIAL DEPOSITS, MID PLEISTOCENE - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
GLLMP-XCZ	*GLACIOLACUSTRINE DEPOSITS, MID PLEISTOCENE - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
FELM-XSV	*FELMERSHAM MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
STGO-XSV	*STOKE GOLDINGTON MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XCZSV	*HEAD - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XVSZC	*HEAD - GRAVEL, SAND, SILT AND CLAY [UNLITHIFIED DEPOSITS CODING SCHEME]*
PEAT-P	*PEAT - PEAT [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD1-XSV	*RIVER TERRACE DEPOSITS, 1 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD2-XSV	*RIVER TERRACE DEPOSITS, 2 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
SGAO-XSV	*SAND AND GRAVEL OF UNCERTAIN AGE AND ORIGIN - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
CWF-XCZSV	*CLAY-WITH-FLINTS FORMATION - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
SUPNM-UKNOWN	*SUPERFICIAL THEME NOT MAPPED [FOR DIGITAL MAP USE ONLY] - UNKNOWN/UNCLASSIFIED ENTRY*

ew220_leighton_buzzard_bedrock

LEX_RCS_I

CKR-CHLK	*CHALK ROCK MEMBER - CHALK*
LESE-CHLK	*LEWES NODULAR CHALK FORMATION AND SEAFORD CHALK FORMATION (UNDIFFERENTIATED) - CHALK*
TRK-CHLK	*TOP ROCK BED - CHALK*
HNCK-CHLK	*HOLYWELL NODULAR CHALK FORMATION AND NEW PIT CHALK FORMATION (UNDIFFERENTIATED) - CHALK*
MR-CHLK	*MELBOURN ROCK MEMBER - CHALK*
TTST-CHLK	*TOTTERNHOE STONE MEMBER - CHALK*
WMCH-CHLK	*WEST MELBURY MARLY CHALK FORMATION - CHALK*
WMCH-LMST	*WEST MELBURY MARLY CHALK FORMATION - LIMESTONE*
ZZCH-CHLK	*ZIG ZAG CHALK FORMATION - CHALK*
GLT-MDST	*GAULT FORMATION - MUDSTONE*
UGS-SIMD	*UPPER GREENSAND FORMATION - SILTSTONE AND MUDSTONE, INTERBEDDED*
WBS-SDST	*WOBURN SANDS FORMATION - SANDSTONE*
WBS-SMCCST	*WOBURN SANDS FORMATION - SMECTITE-CLAYSTONE*
PB-SDLM	*PURBECK GROUP - SANDSTONE AND [SUBEQUAL/SUBORDINATE] LIMESTONE, INTERBEDDED*
PL-LMCS	*PORTLAND GROUP - LIMESTONE AND CALCAREOUS SANDSTONE*
POSA-CALSST	*PORTLAND SAND FORMATION - SANDSTONE, CALCAREOUS*
KC-MDST	*KIMMERIDGE CLAY FORMATION - MUDSTONE*
WEY-MDST	*WEYMOUTH MEMBER - MUDSTONE*
WWAC-MDST	*WEST WALTON FORMATION AND AMPTHILL CLAY FORMATION (UNDIFFERENTIATED) - MUDSTONE*
KLB-SDSM	*KELLAWAYS FORMATION - SANDSTONE, SILTSTONE AND MUDSTONE*
OXC-MDST	*OXFORD CLAY FORMATION - MUDSTONE*
PET-MDST	*PETERBOROUGH MEMBER - MUDSTONE*
SBY-MDST	*STEWARTBY MEMBER - MUDSTONE*
STWE-MDST	*STEWARTBY MEMBER AND WEYMOUTH MEMBER (UNDIFFERENTIATED) - MUDSTONE*

ew221_hitchin_superficial

LEX_RCS_I

	ALV-XCZSV	*ALLUVIUM - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
	LOFT-DMRC	*LOWESTOFT FORMATION - DIAMICTON WITH CHALK RAFTS*
	LOFT-DMTN	*LOWESTOFT FORMATION - DIAMICTON*
	ODT-DMTN	*OADBY MEMBER - DIAMICTON*
	GFDMP-XSV	*GLACIOFLUVIAL DEPOSITS, MID PLEISTOCENE - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
	GLLMP-XCZ	*GLACIOLACUSTRINE DEPOSITS, MID PLEISTOCENE - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
	KGCA-XSV	*KESGRAVE CATCHMENT SUBGROUP - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
	LTH-XSV	*LETCHWORTH GRAVELS FORMATION - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
	ALF-XSZ	*ALLUVIAL FAN DEPOSITS - SAND AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
E	HEAD-XCZSV	*HEAD - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
	HEAD-XVSZC	*HEAD - GRAVEL, SAND, SILT AND CLAY [UNLITHIFIED DEPOSITS CODING SCHEME]*
	PEAT-P	*PEAT - PEAT [UNLITHIFIED DEPOSITS CODING SCHEME]*
	RTD1-XSV	*RIVER TERRACE DEPOSITS, 1 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
	RTDU-XSV	*RIVER TERRACE DEPOSITS (UNDIFFERENTIATED) - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
	CWF-XCZSV	*CLAY-WITH-FLINTS FORMATION - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
	SUPNM-UKNOWN	*SUPERFICIAL THEME NOT MAPPED [FOR DIGITAL MAP USE ONLY] - UNKNOWN/UNCLASSIFIED ENTRY*

ew221_hitchin_bedrock

LEX_RCS_I

LC-CLSISA	*LONDON CLAY FORMATION - CLAY, SILT AND SAND*
LMBE-CLSISA	*LAMBETH GROUP - CLAY, SILT AND SAND*
CKR-CHLK	*CHALK ROCK MEMBER - CHALK*
LESE-CHLK	*LEWES NODULAR CHALK FORMATION AND SEAFORD CHALK FORMATION (UNDIFFERENTIATED) - CHALK*
NPCH-CHLK	*NEW PIT CHALK FORMATION - CHALK*
TRK-CHLK	*TOP ROCK BED - CHALK*
HCK-CHLK	*HOLYWELL NODULAR CHALK FORMATION - CHALK*
HNCK-CHLK	*HOLYWELL NODULAR CHALK FORMATION AND NEW PIT CHALK FORMATION (UNDIFFERENTIATED) - CHALK*
MR-CHLK	*MELBOURN ROCK MEMBER - CHALK*
TTST-CHLK	*TOTTERNHOE STONE MEMBER - CHALK*
WMCH-CHLK	*WEST MELBURY MARLY CHALK FORMATION - CHALK*
ZZCH-CHLK	*ZIG ZAG CHALK FORMATION - CHALK*
GLT-MDST	*GAULT FORMATION - MUDSTONE*
WBS-SDST	*WOBURN SANDS FORMATION - SANDSTONE*

vii) Analysis of the discovery circumstances of each site

Drawing on all the online and hard copy British and French sources from which the site lists were compiled, I identified the discovery circumstance of each site and recorded it on my site lists. I colour-coded the lists by category – surface/chance finds, gravel or brick-pit quarrying, infrastructure construction, domestic building works, archaeological excavation/fieldwalking, antiquarian collecting, or circumstances unknown (for artefacts either with no specific provenance or those identified from Museum accession cards. Entries with 'found' specified in the description were treated as surface/chance finds even where no further information was available). I treated early multiple finds in the same area by a single person – e.g. those collected in the area around Lavant by the Reverend Shaw at the turn of the 20th century – as surface/chance finds rather than excavation/field-walking, although some may have been the result of systematic searching.

I applied the same categories and colour-coding to the list of French sites, then analysed the lists by category to determine the impact of each category on the archaeological record and identify any differences between the study areas. The results of these analyses, and their implications for distribution patterns in the archaeological record are presented in Chapters Nine and Ten.

viii) Summary

In this chapter I have explained and justified the methodology used in my research, including my working hypothesis for testing the impact of differential Clay-with-flints survival on the distribution of the British archaeological record and my development of a geomorphological model for the Chalklands of both southeast Britain and northwest France. I have described how I compiled an extensive list of findspots for my study areas, my creation of geological findspot distribution maps and the identification of the geological context of each findspot, in particular exploring the relationship between findspot distribution and surviving Clay-with-flints superficial deposits. I have outlined the different issues encountered in creating the maps and findspot lists and the solutions I employed, in addition to describing the different analyses undertaken. I have also explained the definitions and methodological conventions I used both in

compiling my site lists and in carrying out my analyses. My results, discussed in Chapters Nine and Ten, will demonstrate that a number of factors have had a substantial impact on the creation of the Lower-Middle Palaeolithic archaeological record. It is, however, geological context and geomorphological change that have had the greatest effect on findspot distribution patterns, with significant implications for our current understanding of Lower-Middle Palaeolithic landscape preference.

Chapter Five. The geomorphology of the Chalk uplands of southeast Britain and northern France: implications for the archaeological record.

i) Introduction

In this thesis I argue that geomorphological processes have had a greater effect on findspot distribution patterns than any other external factor, with significant implications for their use in interpreting human behaviour. A major theme of my research has, therefore, been the necessity of understanding the geology and geomorphology of an area, in this case the Chalk uplands of southeast Britain and northwest France, before there can be any truly meaningful interpretation of its archaeological record. In this chapter I address the extent to which these Chalk landscapes have changed during and since the Pleistocene and any similarities and differences between my core and control study areas. I consider the implications of those changes and differences for artefact distribution patterns and the significance of the survival or removal of superficial deposits for artefact preservation or release. Taking in turn each of the geomorphological factors with most significance for the formation of the archaeological record of northwest Europe, I focus especially on the evolution of the major fluvial drainage systems and their terraces and on the formation of the dry valley networks which are the most significant landforms of the Chalk downlands.

The geomorphology of a landscape and its geology are key to understanding the Lower-Middle Palaeolithic archaeological record (Wymer 1968). It has been argued (Hosfield 1998, 267) that the bulk of that record is the product of geomorphological processes: the repeated transportation of artefacts through a cycle of erosion, movement and deposition. The Unified Palaeolithic Landscape Approach that underpins this thesis addresses the structuring of the known Palaeolithic record by focussing on how all parts of that record, from all sectors of the landscape, have been preserved and/or become visible. As each landscape has its own rhythm of artefact capture and release (Pope *et al.* 2016) the archaeological record will be strongly controlled by geomorphology.

A wide range of geomorphological factors have influenced the formation of the archaeological record, including the nature of the underlying bedrock

and superficial deposits, climatic cycles (affecting sea-level, drainage patterns and river terrace formation) and associated glacial and periglacial processes. Although periglacial processes have, arguably, had the greatest impact on the Chalk uplands, all these factors must be understood and taken into account when considering artefact distribution patterns and their use in interpreting early human landscape preference. An awareness of changes in British Geological Survey (BGS) terminology over time is also required when reading geological maps of different dates and interpreting earlier reports on the geological context of sites.

This research focuses on Clay-with-flints and loess superficial deposits because of their potential for the preservation and/or release of artefacts and the implications for the archaeological record. Found on the Chalk interfluves of southern England and northern France, Clay-with-flints deposits were formed by weathering of the Palaeogene sediments, overlying the Chalk from which the flints were ultimately derived. Because Clay-with-flints forms a hard, protective layer it preserves and retains archaeological artefacts, releasing them only when deposits become sufficiently weathered to allow their release into the ploughsoil, are transformed into colluvium or disturbed by quarrying. Archaeological levels in northern France can be preserved under loess deposits up to 10m deep, meaning sites are generally discovered only through excavation,

The fact that Chalk interfluves capped with Clay-with-flints have undergone only minor erosion or deposition since the Cromerian (Catt 1986) means that in southeast Britain flint artefacts are found on or close to the surface, occurring in subsurface strata only where other deposits, principally loess, have accumulated in dolines and other infilled hollows. In northern France, where thick aeolian loess overlies the Clay-with-flints, surface finds are rare and artefacts deeply buried, resulting in significant differences in the archaeological records of the two regions (*cf.* Chapter Eight). Many French primary context Middle Palaeolithic sites have been discovered, for example at Havrincourt, Pas-de-Calais, where four archaeological horizons have been identified within loess-palaeosol sequences locally reaching >6m thickness ((Antoine *et al*. 2015; Antoine *et al.* 2016; Guerin *et al.* 2017). The site at Verdilly Les Bois des Peupliers (Somme) a depot linked with the construction of the TGV Est, illustrates what happens when the protective loess cover is lost. Although an occupation area covering

~7500m^2 was traced, this had probably continued for some distance to the north-east and south-west but the archaeology in those areas had been destroyed because of loss of the loess cover. Unfortunately, Britain's very thin loess deposits and the widespread loss of many earlier soils by glacial and periglacial slope erosion mean British Quaternary palaeosols rarely provide the sort of high-resolution, detailed history reconstructed from loess-palaeosol sequences in northern France and surrounding areas (Antoine *et al.* 2015; Catt 1996).

In both Britain and continental Europe, the major aggradational river terraces have provided the bulk of evidence for Lower-Middle Palaeolithic human activity. They also account for a high proportion of the interglacial sites preserved within warm-climate sediments, primarily in periglacial and fluviatile sequences (Bridgland 2000; 1995; Wymer 1968). Comprehending drainage network evolution and river terrace formation processes is crucial to accurate interpretation of the archaeological record. Understanding differences in terrace formation as a result of changes in the underlying bedrock is equally important. Rivers have migrated across the landscape through time to a greater or lesser extent as a consequence of climate change cycles and river terrace sequences provide a valuable record of that landscape evolution. Under favourable conditions they may act as repositories for evidence of faunal evolution and human occupation (Bridgland *et al.* 2004). The heights of river terraces in all four study regions range between an average of 30m on the South Downs (Kirkaldy and Bull 1940) and two metres on the Hertfordshire rivers Stort and Ash (Catt 2010) and have been used in calculating the median incision rate of 10 metres per 100ka postulated in my geomorphological model of landscape change. This is slightly higher than Maddy's seven metres per 100ka (Maddy 1997) but river incision would have been greater on Chalk, where sideways river migration was difficult or impossible. However, the relative lack of terraces in rivers flowing over Chalk means that any archaeological remains once lying on higher ground (now the plateaux), instead of remaining among terrace deposits, will have been eroded out, washed away by the river and deposited downstream. In addition, the erosion of artefacts from older deposits and their re-deposition in younger gravels is greater and its influence increased for terrace assemblages in river systems flowing over Chalk than in those flowing over Tertiary bedrock (Hosfield 1999). Where

the bedrock changes from Chalk to Tertiary, differences in the migration tendency of the river will result in the dumping of any Lower-Middle Palaeolithic artefacts, with gravel and sand deposits nearest the Chalk/Tertiary boundary likely to entrap the majority of artefacts originating from higher upstream. The large archaeological assemblages at Dunbridge (1000 artefacts) and Wood Green (400 bifaces) for example, are sited on the Tertiary/Chalk boundary (Hosfield 1999), representing 'natural' artefact concentrations which are an accident of this location. These factors not only reduce the archaeological record of the plateaux and increase the record of the river valleys, but also explain the formation and location of some 'supersites'. Both factors have implications for the emphasis on river valleys in current interpretations of early human landscape preference (*cf.* Chapter Three).

Neither the Bridgland model of terrace development (Bridgland 1994; 1996; 2000; 2006) nor (owing to the error ranges) the OSL dating of Middle and Late Pleistocene sediments, permit the duration of individual fluvial episodes to be assessed. However, based on Late Glacial/Early Holocene sequences which available evidence for the Late Glacial suggests would have been replicated throughout the Middle Pleistocene (Hosfield and Chambers 2005), individual episodes of fluvial incision/erosion and aggradation occurred across timespans of a few hundred or at most a few thousand years. From an archaeological perspective this is crucial, since the behavioural inferences that can be drawn from an assemblage change in type and scope if their encasing sediments were deposited over 100 rather than 10,000 years (Hosfield and Chambers 2005).

Periglaciation, including dry valley formation, is the geomorphological factor most essential to understanding the evolution of the Chalk uplands. All four study areas for this research were within a periglaciated zone which, during the MIS12 glaciation, lay south of a line drawn between the Bristol Channel and Essex (Ballantyne and Harris 1994). Consequently, I discuss the effects of periglacial processes in some detail in this chapter. Periglacial processes such as cryoturbation, solifluction and solution have all potentially caused spatial alteration of any original anthropogenic patterning in the archaeological remains, with clear implications for the reconstruction of past human behaviour. Since all these features are very common in periglacial landscapes, it can reasonably be assumed that a significant

number of Palaeolithic sites have been affected by them. The consequent disruption of sediment strata and soil horizons makes interpretation of depositional sequences and any palaeoecological and archaeological contents very complex. At Bettencourt-Saint-Ouen, Somme, for example, the slope-parallel preferred orientation of artefacts on Level N2b has been interpreted as sorted stripes resulting from freeze-thaw-induced reorganisation of the archaeological level (Bertran *et al*. 2010).

Although slope gradient, length of exposure, climate and vegetation cover can all affect surface artefact distribution (Boismeier 1991), when periglacial solifluction is added to the sorting process, the effect increases dramatically. The soliflucted Wallingford Fan Gravels, for example, accumulated mainly during MIS12 under periglacial conditions (Horton *et al.* 1981) now occur as discrete patches below the Chiltern escarpment. They contain at least 122 bifaces from 8 sites, all derived from the Chalk slope or escarpment (Wymer 1999). At least as old as the gravels themselves, these clearly indicate human occupation on the Chiltern plateau, rather than on the lower ground where they were found. Hundreds of artefacts have, similarly, been found in soliflucted gravels below the Chalk escarpment, for example at Limpsfield, Surrey. Deep Combe Rock deposits in dry valley bottoms may also contain artefacts soliflucted from the plateaux above, as may soliflucted Head deposits in river valleys on the Chalk. As these examples illustrate, unless the solifluction process and its implications are understood and taken into account, interpretations of the archaeological record are likely to be seriously flawed.

Some of the most significant Lower-Middle Palaeolithic sites in my study regions have been found in solution dolines in the Chalk, 97% of which occur where there is a ‘cover deposit’ over the Chalk and usually within 200m of the margins of that deposit (McDowell *et al*. 2008; Worsley 2016). Concentrated on flat hilltops between or adjacent to river valleys (Wu *et al.* 2016) these subterranean solution hollows gradually worked their way to the surface, eventually collapsing and causing their overlying deposits, including any evidence for human or animal activity, to be captured. During subsequent cold periods the hollows gradually filled with further Pleistocene deposits, preserving palaeosols, faunal remains and, occasionally, *in situ* archaeology (Higginbottom and Fookes 2008). Their preservational

potential is, therefore, enormous. Examples of Lower-Middle Palaeolithic sites preserved in dolines include Worthington Smith's Caddington and Round Green, Bedfordshire sites; Wood Hill, Kingsdown, Kent; Les Terres Sellier, Revelles and 'La Queue de la Forêt, Bettencourt-Saint-Ouen, Somme.

Dry valleys, formed largely as a result of periglacial processes, are the dominant and most obvious landform of the Chalk uplands (Jones 1981) making awareness of the nature and timing of their formation critical to understanding their geomorphological evolution. Although the majority of dry valleys seem to have been initiated before the onset of periglacial conditions, perhaps on a cover of Tertiary deposits (Catt 2010; Williams 1980) their development took place during later cold periods of the Pleistocene, mainly during MIS10 to MIS6 and MIS5d to MIS2 when surface drainage on the Chalk was supported by a thick permafrost layer (Catt 2010; Catt and Hodgson 1976). Dating evidence from the fan of debris at the foot of the Chalk escarpment near Brook, Kent, indicates that at least 33% of the erosion of the dry valleys cut into the face of the escarpment accumulated during the Younger Dryas, ~12,900 to11,400 BP (Kerney *et al.* 1964; Williams 1980). The dry valley networks would therefore have been a less significant feature of the landscape during the Middle Pleistocene, with the Chalk interfluves offering a more continuous land surface, dissected by fewer, narrower river and dry valleys. The gentle nature of the solutional lowering of the surface of the Downs (Catt and Hodgson 1976) may mean there has been limited surface alteration of the Chalk landscape despite long periods of subsurface erosion (Douglas 1976; Williams 1986; Williams 1980) and very little change in the general form of the land surface during the Post-glacial (Williams 1986).

ii) Geological history of southeast Britain and northern France

Geologically and topographically, the regions north and south of the Channel, which comprise the English counties of Kent, Sussex and Hampshire and the French régions of Hauts-de-France and Normandy, show remarkably unifying similarities. They share continuity of both bedrock and superficial deposits, coastal cliffs, gently rolling smooth slopes, dry valleys and long rivers on the Chalk. River valleys in both regions are aligned towards the English Channel, their lower reaches opening into

coastal estuaries reflecting the drowned lower courses of earlier rivers (Gibbard and Lautridou 2003). This close proximity and their many similarities mean that research results obtained in one area can be applied relatively easily in the other (Jones 1981,3).

a) Bedrock Geology

Formation and nature of Chalk

Chalk is a unique type of limestone, stretching from Northern Ireland across Britain to Denmark and south into France and Central Europe (Fig. 5.1). The individual beds are traceable across tens, hundreds and sometimes thousands of kilometres from the UK to France and offshore (Mortimore 2011).

Traditionally, geological maps of the English Chalk showed three divisions - the Lower, Middle and Upper Chalk - corresponding to broad variations in the abundance of flint. The British Geological Survey's (2005) revised stratigraphic framework for the Upper Cretaceous Chalk divides the English Chalk Group into Grey and White Chalk Subgroups, with the base of the Grey Chalk Group marking the start of the Upper Cretaceous. Following the identification of common lithological marker beds across the Paris Basin from the Normandy coast to the Yonne and Aude (Mortimore and Pomerol 1987) the southern England Chalk formations have been formally applied to the Normandy Coast (Mortimore 2001b) and the Somme (FLOOD 1 Project). The Chalk within all the study areas for this research is now divided into nine different Formations (Aldiss *et al.* 2012, 732).

Table 5.1 Summary of lithostratigraphy of the Chalk of southern England

Formation	Typical Composition	Typical Thickness
Portsdown Chalk	Chalk with marl seams, some flint	About 60m
Culver Chalk	Chalk with flint but few or no marl seams	About 70m
Newhaven Chalk	Chalk with marl seams, some flint	45-75m
Seaford Chalk	Chalk with few marl seams, much flint	50-80m
Lewes Nodular Chalk	Nodular, gritty chalk, marls, much flint	35-80
New Pit Chalk	Chalk with marl seams, sparse flint	35-50m
Holywell Nodular Chalk	Nodular gritty chalk with marl seams	25-35m
Zig Zag Chalk	Chalk, some marly, some hard	35-50
West Melbury Marly Chalk	Marly chalks, some hard	15-30

The division between the Grey and White subgroups lies between the Zig Zag and Holywell Nodular Chalks. (Adapted from Aldiss et al. 2012).

The White Chalk is on average >98% pure $CaCO^3$ and one of its most conspicuous features is the rhythmic layering of black flint (Mortimore 2001a). The 'flint maximum' at the base of the Lewes Chalk forms a lithostratigraphical marker horizon throughout the northern part of the Anglo-Paris Basin (Mortimore and Wood 1986).

In Southeast Britain, Chalk outcrops extensively, especially on the Chilterns, North and South Downs (Fig. 5.1) usually to < 250m thickness and dipping gently at <2° (Aldiss et al. 2012, 738). Such outcrops would have provided ready access to the flint raw material used to make the artefacts now forming the vast bulk of the archaeological record of the Chalk uplands.

Fig. 5.1. Distribution of Chalk bedrock across southern Britain and northern France

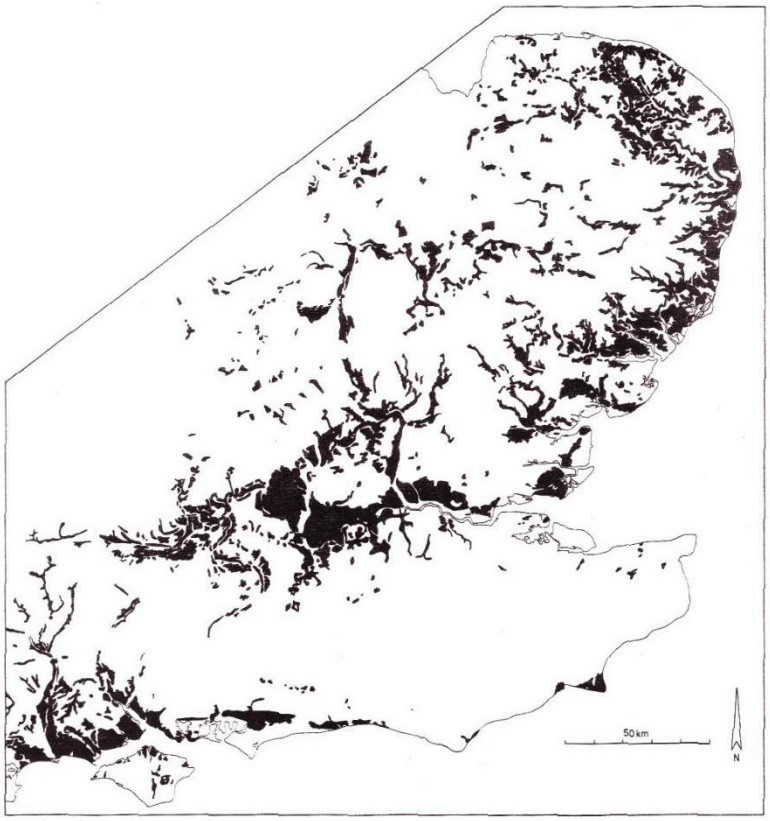
(Reproduced with permission of OneGeology. All rights reserved). The Chalk Bedrock is depicted in pale green. The general location of my core and control study areas is also indicated.

Flint

Flint is a very hard, brittle, siliceous material, its significance for the understanding of early human behaviour lying in its use to make stone tools for a million years.

Because of its resistance to destruction, flint is also present in almost all Tertiary and Quaternary rocks resulting from Chalk denudation. The major pebble-forming lithology in south-east England, it is the most important component in the Quaternary gravels of the area, the largest spreads of which are associated with river valleys and are generally regarded as terrace deposits (Gibbard 1986). It is these gravels which have been so heavily exploited for aggregate extraction during the past 200 years, with consequent implications for the archaeological record.

Fig. 5.2 Generalised distribution map of flint-rich gravel at or near ground-surface in south-east England



© Cambridge University Press. *(Reproduced from Gibbard 1986, Fig. 15.1).*

b) Drift (Superficial) deposits

The British Geological Survey (BGS) now uses the term 'drift' for all superficial deposits, both natural and man-made (McMillan and Powell 1999). Although ~90% of the near-surface geology of the British Isles comprises Quaternary superficial deposits (Booth *et al.* 2015) they are only patchily preserved on many Chalklands outside the London Basin (Jones 1981). Only an estimated 16% of the Chalk landscape is blanketed by colluvium and a further three percent obscured by thick alluvium (Allen 1991). The London and Hampshire Basins, encompassing all three of the

core study areas for this research, are filled mainly with Palaeogene sediments and there are virtually no surviving Neogene deposits in southern England (Catt 2010; Jones 1999a).

Clay-with-flints

Across north-western Europe, plateaux and interfluves on Cretaceous rocks are almost invariably masked by flint-bearing, unconsolidated formations termed Clay-with-flints in English and Résidu à silex, Argile à silex or *formations residuelle à silex (RS*) in French. These deposits contain variably weathered flints, derived ultimately from the Chalk. These are generally unbroken in France but broken in all but the lowest layers in England (Quesnel *et al*. 2003). In north-western France the Clay-with-flints is buried under deposits of loess récents and, sometimes, loess anciens (Antoine *et al.* 1998).

Lower and Middle Palaeolithic artefacts found in relation to deposits mapped as Clay-with-flints by the BGS form a significant component of the British Palaeolithic archaeological record. These are found on the Chalk interfluves of southern England, most extensively on the Chilterns, North Downs and parts of the Berkshire and Wessex Downs but with numerous smaller patches surviving elsewhere. The northern limit of the Clay-with-flints on the Chilterns, between Luton and Welwyn, coincides approximately with the inferred ice margin of the MIS12 (Anglian) glaciation of Britain (Catt 1986). In western England, where Chalk is absent, a similar stony clay containing chert fragments (the Clay-with-flints-and- cherts) rests on the Upper Greensand from which the chert fragments are derived (Quesnel *et al.* 2003).

In France, microfauna preserved in the hollow flints of the Clay-with-flints demonstrate the preservation of the parent Chalk stratigraphy – i.e. the Clay-with-flints corresponds to *in situ* weathering. However, in both countries an important part of the clay component is derived from a thin veneer of basal Tertiary sediment overlying sub-Tertiary marine erosion surfaces of various Palaeogene marine transgressions (Quesnel *et al.* 2003). For example,on the Sussex Downs isolated patches of Clay-with-flints rest on dissected remnants of an inclined plane cut across the Upper Chalk, which corresponds to the sub-Palaeogene erosion surface of an East-West syncline (Hodgson *et al.* 1967). Gentle mid-Tertiary (Alpine)

folding of the sub-Palaeogene surface before it was exhumed also often explains the distribution of Clay-with-flints and its relationship to features of the Chalk plateau (Quesnel *et al.* 2003). On the Chilterns, for example, the warped, non-planar land surfaces capped by Clay-with-flints are parallel to gentle monoclinal flexures in the underlying Chalk (Moffat *et al.* 1986).

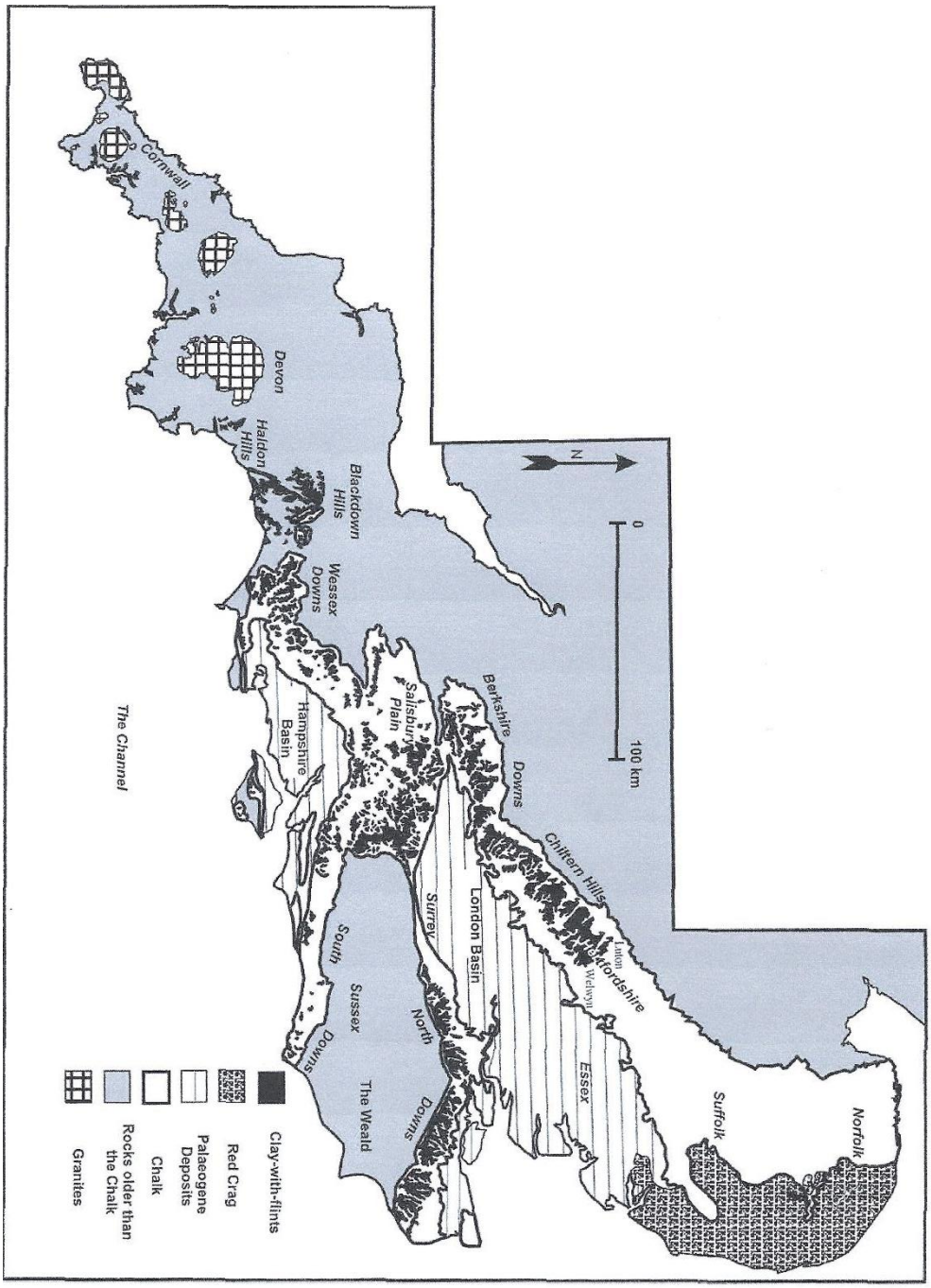
Once the Palaeogene deposits were stripped back by sub-aerial (locally also marine) late Tertiary and early Pleistocene erosion to the point where they were thin enough to become permeable, weathering of the basal remnant and soil formation processes began. Most of the English Clay-with-flints was formed during this later period (Catt 1986; Quesnel *et al.* 2003). Beneath the Palaeogene remnant, percolating acidic water dissolved the uppermost layers of the Chalk, releasing flint nodules which became incorporated into the disturbed basal Palaeogene deposits by frost action during Quaternary cold stages. This process produced a deposit which, in wet weather, became a sticky clay at surface level, changing to a solid 'concrete-like' material just below the saturated surface. In very dry weather surface cracks developed but the Clay-with-flints remained very hard (Scott-Jackson 2000). During interglacials, the Clay-with-flints protected the pre-Tertiary surface but fluvial erosion of the Clay-with-flints and destruction of that surface recommenced whenever the ground was frozen (Catt 1996; Catt 2000). The residual deposits formed through this cyclical process, thickest near the summit ridges, include materials of differing composition and origin (Avery 1964; Hodgson *et al.* 1967).

In both England and France it is this second generation of Pliocene/Quaternary Clay-with-flints that outcrops today. Formed as a result of falls in base-level (uplift in southern England), dissolution of the Chalk, cryoturbation, clay illuviation and collapse of Cenozoic remnants, it shares the same petrographical, mineralogical and geochemical features north and south of the Channel (Quesnel *et al*. 2003).

Clay-with-flints is the starting product for transformation into colluvium, moved by periglacial slope processes and slope wash (Lawrence 2005). Once soliflucted and moved downslope, however, it is no longer classified as Clay-with-flints by the BGS, but as Head (http://www.bgs.ac.uk/lexicon/lexicon.cfm?pub=CWF). In France, the term *'biefs à silex'* is applied to such valley side head deposits (Antoine *et al.*

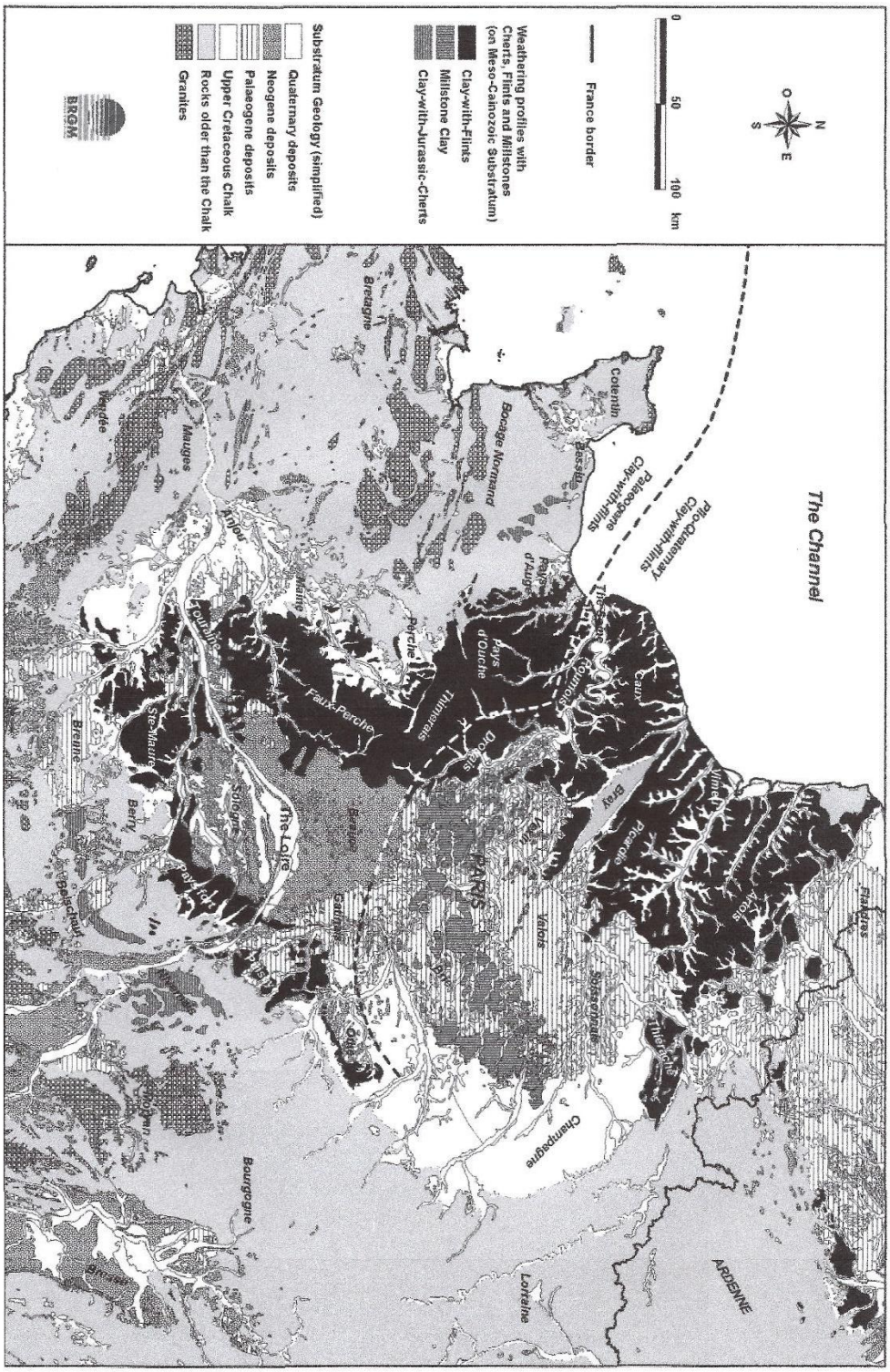
1998; Laignell *et al.* 1998). This solifluction of plateau deposits, together with any artefacts preserved therein, has implications for the analyses of findspot distribution by geological context which form a substantial part of my research and for interpretations of early human landscape use based on those findspot distributions.

Fig. 5.3 Clay-with-flints distribution north of the English Channel



Based on 1:25,000 maps of the soil survey and Land Research Centre. The Chalk outcrop is outlined by a continuous line (Reproduced from Quesnel et al.2003 Fig.1. © John Wiley and Sons.).

Fig. 5.4. Clay-with-flints distribution south of the Channel



Distribution of plateau Clay-with-flints, Millstone Clay and Clay-with-Jurassic-Cherts Based on 1:50,000 to 1:1000,000 geological maps of the BRGM. (Reproduced from Quesnel et al.2003 Fig. 3. © John Wiley and Sons).

The term ‘Clay-with-flints’ was first used in 1861 by Hull and Whitaker in their *Geology of parts of Oxfordshire and Berkshire* to refer to the homogenous reddish-brown, frequently black-stained clay containing unworn flint nodules that forms a thin layer resting directly on the Chalk. This often underlies thicker, more heterogeneous drift incorporating residual material from the Palaeogene deposits (Catt 1986) which Loveday (1962) called Plateau Drift, renaming Hull’ and Whitaker’s Clay-with-flints as Clay-with-flints ‘*sensu stricto’*. Clay-with-flints *sensu stricto* consists largely of clay and up to 50% flints. Excluding any deposits with appreciable quantities of sand, silt and stones, it varies rapidly in depth over short distances, from a few inches to several feet, forming a fairly continuous layer following the Chalk surface (Catt 2010).

Loveday’s distinction between Clay-with-flints *sensu stricto* and deposits equivalent to Plateau Drift can also be made on most Chalk interfluves south of the Chilterns. Sand forms 30 to 70%, clay 20 to 60% and silt usually about 15% of the different ‘Plateau Drift’ types (Catt 1986; 2010) and its thickest development appears to be restricted to the London Basin. On the Chilterns it is normally five to 25 feet thick whereas on the other southern English Chalklands, as well as on the higher parts of the Chilterns, it is generally thinner. On the dipslope interfluves of the Sussex South Downs, only thin superficial deposits survive (Catt and Hodgson 1976; Jones 1981; Loveday 1962) which, I will argue, is a factor in the lower number of sites located in that section of the South Downs. On the shoulders of valleys and the scarp slope, Plateau Drift feathers out to expose the Clay-with-flints *sensu stricto* (Catt 2010).

The Old Series geological maps of southern England showed Clay-with-flints ‘*sensu stricto’* and the overlying deposits, often also clayey and flinty, separately. However, the extreme thinness of Clay-with-flints *sensu stricto* (usually <1m) led to difficulties in separating them at the 1:63,360 scale and all BGS-mapped Clay-with-flints deposits in the New Series maps encompass both (Clay-with-flints ‘*sensu lato’*). All map and findspot analyses and calculations in this study, based on BGS digital geological data are, therefore, unavoidably based on Clay-with-flints *sensu lato*.

Loess

During the Quaternary, approximately 10% of the Earth's mid-latitude land surface was covered by loess, a homogeneous, structure-less, highly porous, buff-coloured wind-blown silt produced during glacial episodes as a result of decreased rainfall, scarcity of vegetation, increased wind strength and the production of large amounts of fine-grained particles by frost-shattering of rocks and glacial abrasion (Bertan *et al.* 2016; Murton and Giles 2016). The continuous, primarily Weichselian loess belt of northwest Europe varies widely in width, from 10km to 200km in Northern France (Haase *et al*. 2007). Sometimes >300m thick in central Asia, loess rarely exceeds 10m in western Europe (Clarke et al. 2007).

Loessic deposits contain significant amounts of clay, their eminent suitability for brick-making (Murton and Giles 2016) leading to their large-scale exploitation during the 19th and 20th centuries when hand-dug extraction resulted in significant archaeological discoveries such as Worthington Smith's Caddington sites, containing primary context artefact horizons. Brickearth is a deposit associated to the Coombe Rock now blanketing the floors of many dry valleys and is widely interpreted as loessic material reworked by solifluction (Ballantyne and Harris 1994). Artefacts in the archaeological record recorded as found in valley-bottom Coombe Rock could, therefore, have originated on the Chalk Plateaux, which must again be borne in mind when interpreting distribution maps.

On older BGS maps, thicker loess deposits in southern England are shown as brickearth, head brickearth or river brickearth, terms now regarded as obsolete, although not all may have had a loessic origin. Some in the lower Thames Valley, for example, were deposited as floodplain alluvium under interglacial conditions (Ballantyne and Harris 1994; McMillan and Powell 1999). The term 'fluvio-aeolian silt' is now used for these deposits in BGS map classification which - as with deposits mapped as Clay-with-flints - must be borne in mind when using geological maps of different dates.

In France the main loess accumulations occur in the Lower Seine valley, the eastern Somme Basin and the north of France (Antoine et al. 2003a) and the Somme Basin has been the focus of most recent loess research (Antoine *et al*. 2016). These regions have a continuous ('Loess de Couverture') or sub-continuous loess cover, up to three to four metres thick

in Picardy and locally up to eight metres thick, including on the gentle leeside slopes of asymmetrical valleys. On the plateaux, the loess is generally thinner (four to five metres), with significant gaps in the sequence.

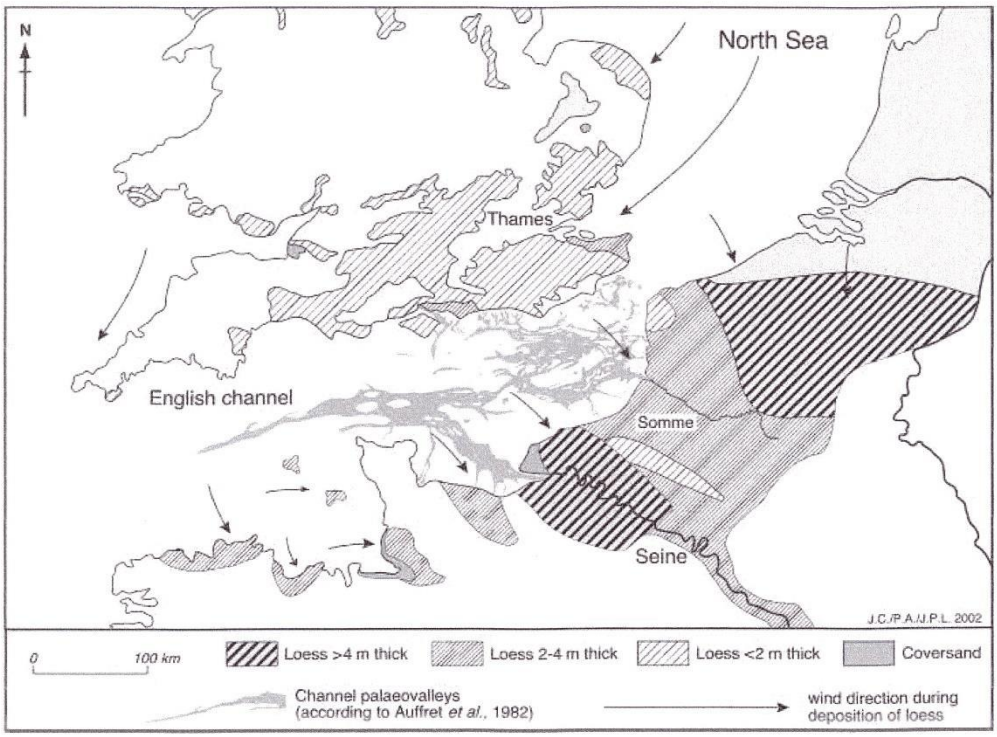
Like the neighbouring regions of Normandy and Nord Pas de Calais, Picardie can be separated into two parts, east and west, with a transition from 'loess ancien' (pre-160-170ka) to 'loess recent' occurring around Amiens. The advantage of regions with loess cover is that they provide upstream and downstream stratigraphic markers for the whole system, in the case of the Somme at Amiens-Montières and Abbeville (Sommé 1996).

The main accumulations of typical calcareous loess are related to the Upper Weichselian (MIS 2) and Upper Saalian (MIS6) and prior to 160-170ka loess survival is generally restricted to sediment traps –i.e. fluvial and marine terraces exposed to the east or northeast (Antoine *et al.* 2003a). At Grâce, near Amiens, for example, a very thick loess and palaeosol sequence comprises seven interglacial-glacial cycles between the top of a late Lower Pleistocene alluvial terrace gravel unit and the chalk slope (Antoine *et al*. 2003a). On the plateaux, thick loess and palaeosol sequences in dolines have preserved primary context Acheulean and Middle Palaeolithic sites – e.g. Etricourt-Manancourt, Somme (Antoine *et al*. 2015).

British loess deposits are primarily patchy and thin, often more a soil contaminant than a major discrete band of pure sediment (Goudie 1990). British loess is generally less than one metre thick, with unweathered calcareous loess at its thickest in southeast England, in areas adjoining the Thames Estuary and on the Sussex coastal plains (Assadi-Langroudi 2019; Clarke *et al*. 2007). Re-worked loessal-derived sediments are found within the alluvium of all Sussex rivers and every major Wealden river valley (Burrin and Scaife 1984; Scaife and Burrin 1983) but, although many floodplain deposits of southern England probably contain loessal deposits, it occurs only rarely elsewhere (Catt 1977). Originally more extensive, the loess has been removed from many areas by Late Devensian solifluction, Late Devensian and Early Holocene stream erosion and anthropogenic colluviation. Isolated deposits of older (pre-MIS5e) loess do occur in the Thames and Gipping Valleys, within dolines on the Chiltern Hills and at Boxgrove, Sussex, but there is otherwise very little 'loess ancien' preserved

in Britain and, as in France, most deposits are MIS2 to MIS4 (Burrin and Scaife 1984; Catt 1977; Goudie 1980).

Fig. 5.5. Loess distribution and thickness in southern England and northern France



(Reproduced from Antoine et al. 2003a Fig.1).

The main differences in thickness and extent of the loess deposits between southern England and northern France are linked to their location in relation to the source areas, to ice sheets and to the main wind direction (northwest to north-northwesterly in France and western England but northeasterly in eastern England (Antoine *et al.* 2003a). Britain's location at the western extremity of the European loess and coversand belt means the supply of aeolian sediment was limited, the fairly oceanic climate resulting in considerable erosion during and after deposition (Catt 1977). Its coarser grain size may also have rendered it less stable and more prone to reworking (Wenban-Smith *et al.* 2010*).* As a result, the probability of finding loess-protected British Lower-Middle Palaeolithic upland sites with several occupation levels, comparable with those now being discovered in France is severely reduced.

iii) Landscape evolution during the Quaternary

Throughout the Pleistocene, the build-up and retreat of ice sheets drove enormous climatic and landscape changes, affecting drainage patterns, dry

valley and river terrace formation, isostatic uplift and global sea-level. Mid-latitude regions, including Great Britain, have been particularly sensitive to global-scale Quaternary climatic change, with indications that changes of up to 10°C can occur within a few decades (Lowe and Walker 1997). They experienced significant landscape evolution as a result. However, the present British land mass was at no time completely buried under ice and in southeast Britain, at least, Pleistocene denudation was concerned mainly with accentuating pre-existing landform patterns (Jones 1980).

a) Formation of escarpments and secondary escarpments

The Chalk everywhere forms an escarpment with summit elevations usually above 180m, rising occasionally to 260m (Goudie 1990; Jones 1999a). In some areas, notably Sussex, the dip-slope is interrupted by a discontinuous 'secondary escarpment' covered with shallow spreads of Clay-with-flints (Small and Fisher 1970; Williams 1986). The escarpments have suffered relatively little retreat since the Pleistocene (Jones 1986; Small 1961; Williams 1980).

The cuestas forming the northern and southern rims of the London Basin are broadly comparable but show marked differences from those fringing the Hampshire Basin (Jones 1999a). They vary in width and steepness between 15 and 25 km wide on the Berkshire Downs and Chilterns (0-2° dip) to less than one kilometre at Guildford, North Downs, where the dip exceeds 30° (Jones 1981). A slope of ~29° to 30° is the maximum repose angle for Chalk slopes in southern England (Goudie 1990), resulting in the 'classic' Chalk Downs topography still visible today and which has changed relatively little since the Pleistocene. Apart from occasional river and/or wind gaps, the scarp crests are largely unbroken, with only sixteen unevenly distributed through-gaps in 282.84kms (175.75 miles) of escarpment on the Chilterns, North and South Downs (Small 1961).

The Pewsey-London Platform inversion appears a particularly important structural divide in southeast Britain, separating areas with well-developed surviving Palaeogene (Tertiary) deposits to the north from areas to the south which suffered denudation in the Neogene (Jones 1999a). This has implications for the survival of Clay-with-flints and the preservation/release of archaeology.

Fig. 5.6. Typical Chalk downland at Hexton, Chilterns.

(Photograph © L. Blundell)

Three major structures dominate the geomorphology of southern England, the most extensive of which is the London Basin Syncline. To its south lies the periclinal flexure of the Wealden-Artois Anticline, the southern end of which sits in the eastern end of the Boulonnais, France. To its southwest is the asymmetrical Hampshire Basin, the shallow synclinal Dieppe Basin appearing to be its eastward extension (Jones 1981). The Somme basin, the control area for my research, is a small watershed only 5,800km^2, the geomorphological features of which are controlled by NW-SE-aligned axial tectonic structures, including the syncline and fault of the Somme valley (Antoine *et al*. 2015).

b) Formation and development of the drainage network

Although less significant in terms of the artefact preservation and release which forms the core of this research, the evolution of the drainage network is important for understanding the landscapes across which early humans moved. During the MIS12 glaciation the Thames, previously draining much of Wales and southern England (Rose 1994) was diverted southwards. The other major river system in southern England at that time was the Solent which, unlike the Thames, remained extra-glacial during its entire history. It entered the Channel area in virtually the same place at periods of active erosion or sedimentation, whereas the Thames markedly extended or

shortened its course in response to external changes (Gibbard and Allen 1994; Gibbard and Lewin 2003).

A ~400km-long network of palaeovalleys, many still linking back into the present-day river system, exists below the English Channel collecting the drainages of southern England and northern France (Auffret and Alduc 1977; Bellamy 1995; Gibbard 1995a; Smith 1985). The present-day Somme, Seine, Solent and numerous minor French and British rivers, including the Arun, Adur, Ouse and Cuckmere, merged into the English Channel during eustatic lowstands to form the Channel River/Fleuve Manche which, at its maximum, was draining almost half of western Europe (Gibbard and Cohen 2015; Gibbard and Lautridou 2003; Toucanne *et al*. 2009;Toucanne *et al.* 2010) seriously impeding early human movement across the Channel region (*cf.* Chapter Three).

Despite the MIS12 changes, the pre-existing Tertiary drainage lines were largely maintained in the region and the major river systems have remained broadly consistent in their alignments for at least 55Ma (Gibbard and Lewin 2003). The large, now dry 'windgaps' in the Chalk escarpments – e.g. at Washington and Saddlescombe on the South Downs, Tring and Wendover on the Chilterns and Merstham on the Surrey North Downs – also date back to the Tertiary, being formed, probably, by rivers that failed to maintain their courses as the water table fell within the Chalk (Catt 2010; Catt *et al.* 2006; Gibbard and Lewin 2003; Jones 1980; Moffat and Catt 1986; Williams and Robinson 1983; Wooldridge and Linton 1955).

However, although maintaining their general courses since the early Palaeocene, the rivers of the southeast were greatly modified during the Pleistocene by marine and glacial influences (Jones 1981), extending or reducing their lengths in response to those external changes. Consequently, today's river system is dominated by relatively small rivers (Rose 1994) with deeply incised valleys resulting from progressive downcutting during periods of substantial rapid climate change (Gibbard and Lewin 2003; Maddy 1997).

The Thames is the largest drainage basin in Britain. While the Middle and Lower Thames flow through the London Basin's Tertiary sands and clays overlying the Chalk, upstream of Reading the river cuts through Chalk and enters the N-S aligned Upper Thames (Gibbard and Allen 1994). Prior to

the MIS12 drainage diversion in the present Thames Valley, its south bank tributaries, including the Medway, Darent, Mole, Wey and Kentish Stour, flowed northeast across the valley to join the river (Gibbard 1979).

The Medway, draining northwards from the centre of the Weald, probably came into existence during the Palaeogene (Bridgland 2003), entering the North Sea Basin separately from the Thames. For much of the Early and early Middle Pleistocene it flowed north across eastern Essex, becoming confluent with the proto-Thames on the Tendring plateau northwest of Clacton. This joint Thames-Medway northward drainage persisted until after MIS11 (Bridgland 2006) migrating progressively southward until eventually forming the present Thames estuary during MIS6 (Catt *et al.* 2006). By this time the Medway was a clearly established south bank tributary of the Thames (Briant *et al.* 2012). This progressively southerly shift, best explained in terms of crustal subsidence over the last 450ka (Rose 2006, 278), also affected other rivers of southern England during the Pleistocene (Allen and Gibbard 1993; Gibbard 1977).

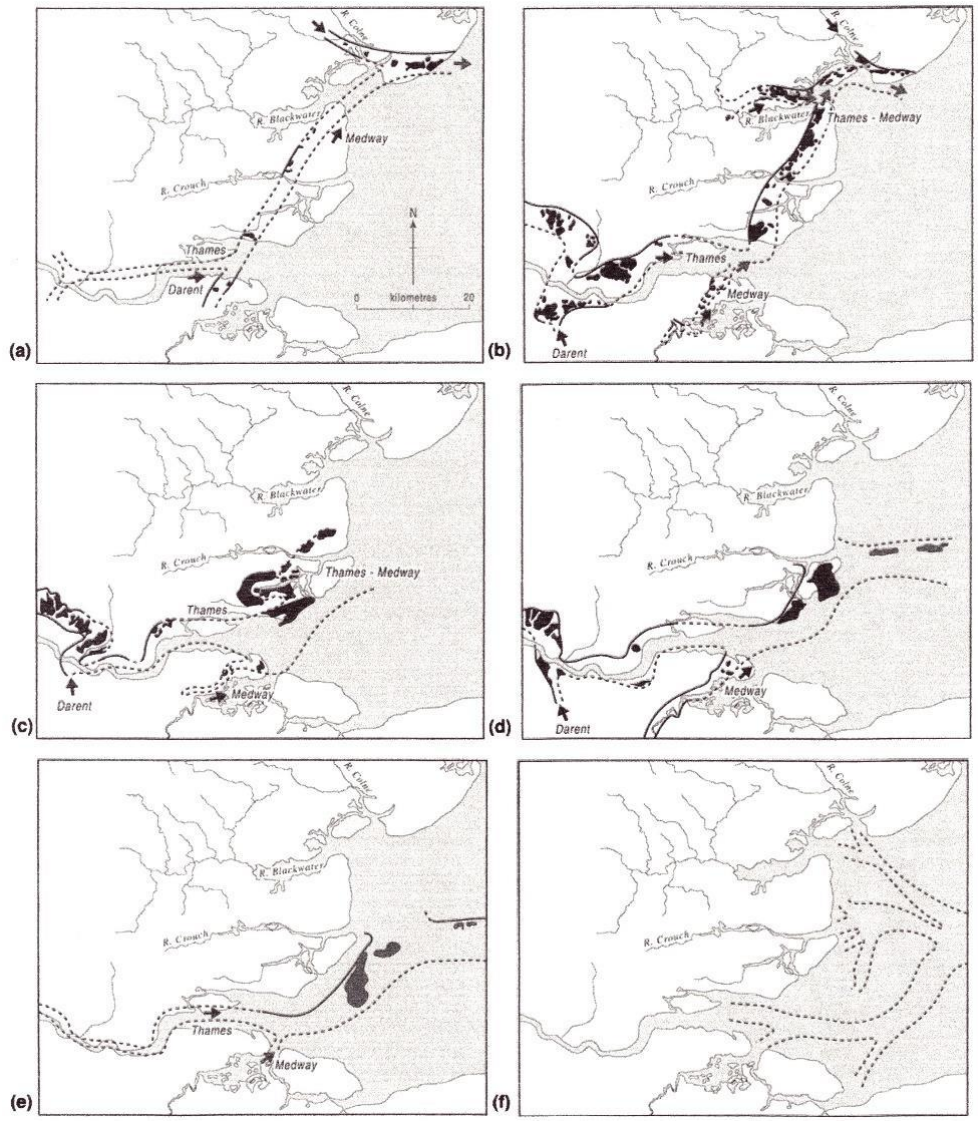
The headwaters of the Darent once drained the area south of Limpsfield, Surrey. By MIS12 its course joined the Medway near Southend-on-Sea and during late MIS12 was confluent with the Thames, and possibly the Cray, near Dartford (Gibbard 1995b). Separated only by narrow watersheds from adjacent valleys draining into the Medway, the Darent decreased in significance with the capture of its headwaters and lower reaches by the Medway (Bridgland 2003; Prestwich 1891; Treacher 1909).

During early MIS12 the Rivers Mole and Wey, draining the extra-glacial Weald, joined near Weybridge flowing NNE from there across the present Thames Valley to eventually join the Thames east of Ware, Hertfordshire (Gibbard 1979) and thereafter migrating south with that river. The Kentish Stour, the most easterly of the south bank tributaries of the Thames, now enters the English Channel on the southern side of the Isle of Thanet but previously followed a succession of northward courses towards a confluence with the now-drowned extension of the Thames in the offshore area east of Burnham-on-Crouch, Essex (Bridgland *et al.* 1998).

Many of the northern tributaries of the Thames formerly draining the Chilterns and adjacent areas, have been lost, leaving the rivers Wye, Misbourne, Colne, Ver and Upper Lea as remnants of a formerly more

extensive network (Jones 1981).The eastern half of the Vale of St Albans is now drained by the Upper Lea and its tributaries - the Mimram (extending north into the now dry monoclinal Lilley Bottom Structure), the Rib and the Beane - all flowing over the Chalk; the western half by the Colne and its tributaries the Mimmshall Brook and the Ver. With the exception of the Ver and the Lea, which originated during MIS12, these modern rivers were probably initiated during MIS10-MIS6 (Gibbard 1977). Only the Upper Lea flows broadly south down the Chiltern Chalk dip-slope, the Lower Lea diverting southeast at the Chalk-Tertiary bounday to eventually join the Lower Thames at Leamouth (TQ394 807), east London.

Fig. 5.7. Palaeodrainage maps showing the progressive southward migration of the Lower Thames and relative positions of the Darent and Medway



***a** MIS12 glacial maximum; **f** Modern estuary showing the submerged and buried channels of the Last Glacial river system. (Reproduced from Bridgland 2006 Fig.9. With permission of the Geologists Association).*

In the Hampshire Basin, the Solent River system was fully developed early in the Pleistocene (Allen and Gibbard 1993). Like the Thames, the Solent and its north-bank tributaries the Avon and Stour migrated progressively southwards throughout the Pleistocene, with the Avon and Stour remaining part of the Solent River for much of the Devensian (Nicholls 1987). During sea-level low-stands the Solent turned southwest east of the Isle of Wight to join the Channel River, until the Wight-Purbeck Ridge, linking the Isle of Wight to the British mainland, was breached by fluvial processes during the Late Devensian or early Holocene (Antoine *et al.* 2003b), drowning much of its lower course.

In Sussex, four main rivers, the Arun, Adur, Ouse and Cuckmere rise in the central Weald, draining southwards through the Chalk scarp of the South Downs and on to the Sussex coastal plain before discharging into the Channel (Antoine *et al*. 2003b). On the dip-slope ephemeral streams (e.g. the Winterbourne, Lewes) flow in response to seasonally high groundwater levels (Potts *et al.*1983). While the Cuckmere, Ouse and Adur have many features in common, the Arun has cut back across the anticlinorum and, with its main tributary the Rother, is encroaching on the neigbouring basins of the Mole and Wey (Kirkaldy and Bull 1940). The northern part of East Sussex is drained by the headwaters of the Medway flowing northward across the Weald, and by the eastern Rother, flowing eastwards to the coast at Rye (Potts *et al.*1983).

In the lower reaches of the Arun, Adur, Cuckmere and Ouse superficial deposits are deep, river gradients low and rivers tidal well inland of the Chalk escarpment. The submerged valleys of these rivers formed during the Pleistocene by extension of the fluvial systems during times of lower than present sea-level, when the inner continental shelf was sub-aerially exposed (Bellamy 1995). In the northeast of the Pays de Bray anticline, Picardy and northern France, the main fluvial systems are the Béthune, Bresle, Authie, Canche and Somme, the latter being one of the largest rivers flowing into the Channel during the Pleistocene (Antoine et al. 2003b). All the rivers of the Channel coastlands occupy well-developed valley systems, their lower parts now drowned by the sea but continuing off-shore. Most also contain sequences of terraces and related sediments in varying states of preservation (Antoine *et al* 2003b). As sea-levels rose and fell in response to climatic fluctuations, the Hampshire, Paris-Dieppe

and Somme Basins fluctuated between a coastal plain with river valleys and an estuarine landscape, as did the Lower Thames (Gibbard 1995b; Hosfield 1999).

c) River terrace formation

The significance of river terrace formation processes for my research lies primarily in the fact that their dominance of the archaeological record has distorted current interpretations of early human landscape use. It is, therefore, important to understand the processes leading to their formation and preservational qualities.

River terrace staircases are found all over the planet (Bridgland 2010; Bridgland and Westaway 2008) recording significant fluvial incision during the Late Cenozoic. Some of the most detailed fluvial records in the world are found in Europe (Bridgland and Westaway 2008, 291) and being in a temperate latitude close to the Atlantic margin the British record reflects strong climate forcing. The most extensive and important British terrace record is that of the river Thames, the Lower Thames late Middle Pleistocene terrace sequence providing an important context of vertebrate and molluscan fauna, Palaeolithic archaeology and glacial-interglacial climatic fluctuation (Bridgland 2010).

According to Vandenberghe (1995) river terraces form on four distinct timescales. Within 100ka glacial/interglacial sequences broadly synchronous with Milankovitch cycles there are 10ka single glacial/interglacial cycles consisting of short unstable phases, alternating with long periods of fluvial inactivity. These short (one thousand year) single phases of instability see strong fluvial incision occur over a very short time-scale. The fourth timescale consists of 100 year lower-order climate changes with well-pronounced local effects. From an archaeological perspective it is the taphonomic implications for secondary context lithic assemblages of alternating short phases of fluvial incision and long periods of relative fluvial inactivity within the 10ka timescale that is most significant (Hosfield and Chambers 2005).

Although many rivers have terrace staircases extending back into at least the early Pleistocene, enhanced terrace formation has occurred since the Middle Pleistocene onset of 100ka climatic cyclicity, when rivers first started forming terraces in synchrony with the glacial/interglacial cycle (Bridgland

2000, 1299) and river valleys became more steeply entrenched (Brigland and Westaway 2008). Similarly consistent patterns of Quaternary valley incision are reported across Europe and beyond (Antoine *et al* 2003b; Bridgland 2000; Bridgland 2006; Bridgland and Westaway 2008; Maddy 1997; Vandenberghe 1995).

Models of river terrace formation

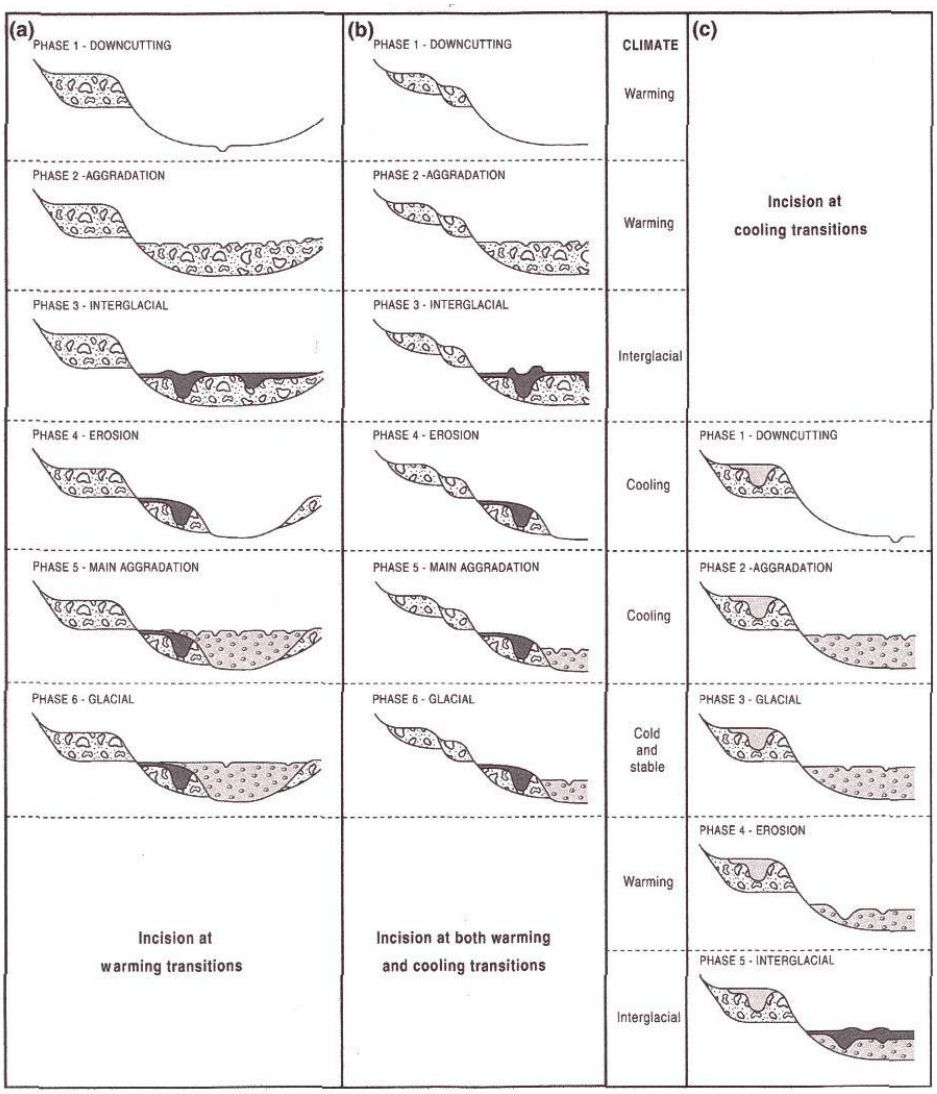
The 'Bridgland Model' of climate forcing, based on work in the Lower Thames Valley, attributes river incision to climate transitions (Bridgland 1994; Bridgland 1995; Bridgland 2000; 2006; Rose 2006). This model is now widely accepted, despite differences as to when, exactly, in the climatic cycle incision occurred.

The model assumes that terrace gravels are the remnants of former floodplain accumulations left on valley-side benches, together with any archaeological remains, by incision into the river valley floor; that the area has experienced uplift; that channel incision through the floodplain floor results from high energy fluvial events and that valley incision is caused by channel migration. Six cyclical phases of river terrace development are envisaged.

The Bridgland model is applicable to the well-integrated parts of river catchments. In non-integrated parts of catchments, however, where river activity is determined by other, independent processes, such as changes in sea-level, the climate signal can be obscured or confused and the process of complex response operates (Rose 2006). Nevertheless, except perhaps near the coast, forcing of river terrace formation by sea-level change was of negligible importance and incision in the upper and middle courses of rivers was totally independent of sea-level fluctuation. The downstream Seine and Somme, for example, were more sensitive to glacio-eustatic control than their upstream courses, which were more directly controlled by climatic variation (Antoine et al. 2000; Antoine *et al.* 2003b; Bridgland *et al*. 2004).

However, although fluvial downcutting during cold-to-warm transitions can be demonstrated for Britain, the most common pattern on the European mainland, even for the nearby River Somme, is for downcutting during warm-to-cold transitions (Antoine 1994; Antoine *et al.* 2000; Antoine *et al*. 2003b; Antoine *et al.* 2007; Bates 1993; Bridgland *et al*. 2004; Bridgland and Westaway 2008; Bridgland and Westaway 2014).

Fig. 5 8. Bridgland model of river terrace formation.

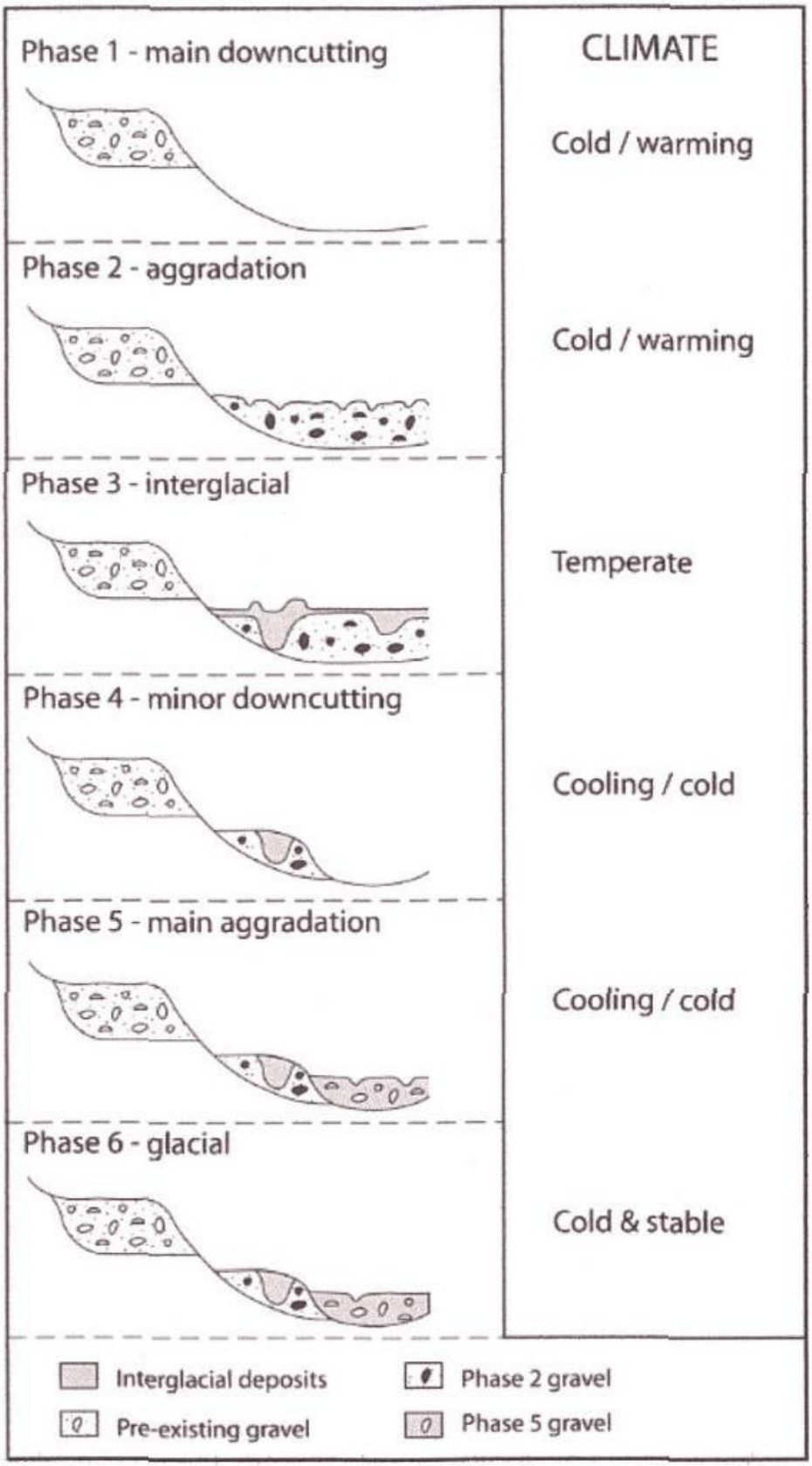


***a)** Original model from with downcutting at warming transitions; **b)** revised model with downcutting at both warming and cooling transitions; **c)** third, possible scenario, with downcutting at cooling transitions to match rivers such as the Somme. (Reproduced from Bridgland and Westaway 2008 Fig.6. With permission of the Geologists Association).*

Challenges to the Bridgland model have come from Gibbard (Gibbard 1985; Gibbard and Allen 1994; Gibbard and Lewin 2002; 2003; 2009; Lewin and Gibbard 2010) and from Murton and Belshaw (2011). For Gibbard (Gibbard and Lewin 2009) the model cannot be applied universally to all depositional sequences underlying terrace surfaces since the majority lack evidence for interglacial sedimentation. Mechanical (principally frost) weathering was more significant than chemical weathering for the rate of landscape dissection and lowering, with climate transitions mostly seeing a reworking of sediments rather than bedrock incision.

Also challenging the view of incision during climate transitions, Murton and Belshaw (2011) attribute incision and planation to very cold and permafrost

Fig.5.9. Murton and Belshaw's model of terrace formation for the river Thames



(Reproduced from Murton and Belshaw 2011 Fig. 1 Derived from Bridgland 2006 and Maddy et al 2001).

conditions, when rivers had limited discharge and hillslopes supplied limited volumes of stony debris into valley bottoms. Incision ceased when increased soil moisture promoted ice segregation and solifluction on hillslopes, enhancing the transport of coarse sediments into the river valleys and replacing incision with aggradation. This is the stage at which artefact-rich deposits like the Wallingford Fan Gravels, Bapchild Coombe Rock and the Head gravel at Twydall, Gillingham would have been transported from plateau top to valley bottom, distorting the archaeological record. Overall, during Pleistocene periglacial conditions rivers alternated between bedrock incision and gravel aggradation. While differing over some of the processes involved, like Gibbard and Lewin's (2009) model they attribute valley incision to periglacial conditions rather than climate transitions or interglacials.

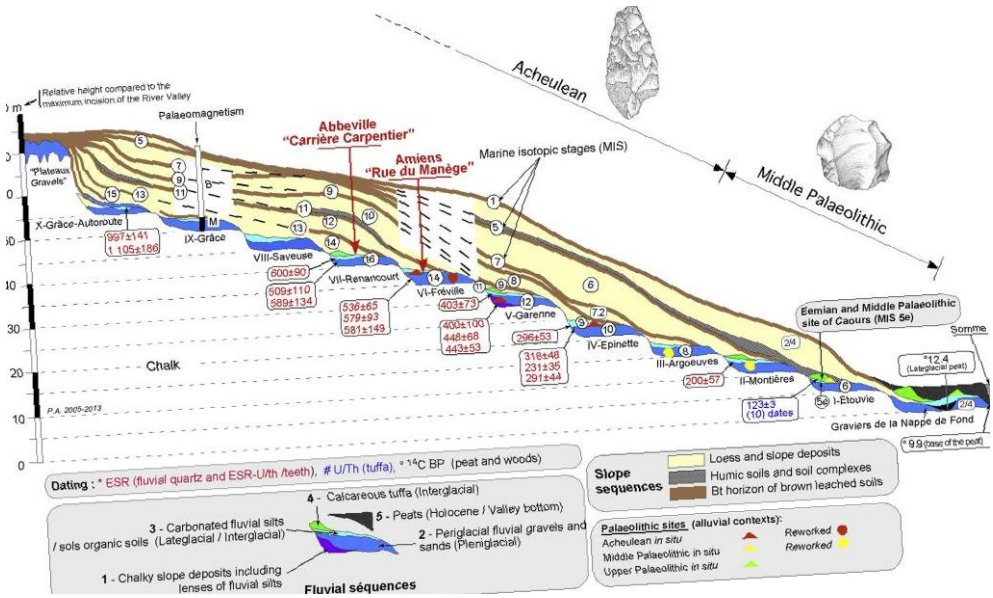
Approximate 100ka cyclicity in terrace formation is not, however universal. Many sequences have fewer than one terrace per 100ka cycle and some have more, with rivers with more terraces being locally more common on the western extremities of the European continent, where Atlantic influence has been greatest (Bridgland 2010). The Somme, for example, has a single extra terrace, formed during MIS7 (Antoine 1994; Antoine *et al*. 2000). The Solent developed almost two terraces per 100ka cycle during the late Middle Pleistocene (Westaway *et al.* 2006) while its tributary, the River Test, has 11 numbered terraces. Recent revision of the Test stratigraphy (Hatch *et al*. 2016) has clarified correlations within and between these archaeologically important sediments. Another Solent tributary, the Hampshire Avon, has >10 terraces (Clarke and Green 1987).

Rivers with many more terraces than 100ka climatic cycles may have seen terrace formation at both transition episodes (Bridgland 2000; Bridgland 2001; Westaway 2010), although the phenomenon could equally be a response to late Milankovitch substages MIS 11b and MIS9d (Westaway *et al.* 2006). Rivers with fewer terraces presumably responded only to the more significant climatic cycles (Bridgland and Westaway 2008).

Ten stepped alluvial formations have been identified within the downstream Somme terrace sequence between the present coast and Amiens, rising from plus five to 6 metres to +55m relative height above the modern valley bedrock (Antoine *et al*. 2000; Gargani *et al*. 2006). These result from a

combination of lateral erosion linked to channel migration (0-500m) and vertical erosion (incision) of five to six metres, the most recent incision occurring during the Weicheslian (Antoine 1994; Antoine *et al.* 2000; Antoine *et al* 2003b; Antoine *et al*. 2014; Tuffreau *et al.1997*).

Fig. 5.10 Somme river terraces.



(Reproduced from Antoine et al. 2015 Fig. 2).

Like the Thames, chronostratigraphic sequences have been created for the Somme terraces, based on morphostratigraphy; biostratigraphy chronostratigraphy and magnetostratigraphy, U/Th, ESR and TL dating (Antoine 1990; 1994; Antoine *et al*. 2000; Bates 1993; Bridgland *et al.* 2008). As a result, the geological, chronological and palaeoenvironmental context of the region over the past one million years is among the most clearly established in the world (Antoine *et al.* 2014).

The construction of a chronostratigaphy for river terraces in the Thames and Somme valleys has made it possible to insert archaeological sites into a common chronological framework, enabling the chronostratigraphic calibration and palaeoenvironmental reconstruction of Palaeolithic occupations and the identification of patterns of human behaviour (Antoine *et al.* 2014).

Western European loess-palaeosol sequences also preserve a significant terrestrial record of Quaternary history and the best loess sequences are well-suited to studying millennial-timescale environmental changes. The

establishment of a litho-pedostratigraphic and chrono-climatic reference sequence for the loess of northern France also facilitates the study of human-climate-environment relationships in western Europe.

Table 5.2 Correlation of the Quaternary terraces of the Middle/Lower Thames with the MIS record.

Terrace formation Middle/Lower Thames	Members Lower Thames	Climate	Age	δ
Shepperton	Tilbury Alluvial deposits	Warm	Holocene	1
	Shepperton Gravel	Cold	Devensian	2
Kempton Park/East Tilbury Marshes	E. Tilbury Marshes	Cold	Devensian	5d-2
	Upper Gravel			
	Trafalgar Square deposits	Warm	Ipswichian	5e
	East Tilbury Marshes Lower Gravel	Cold	Late Saalian	6
Taplow/Mucking	Mucking Upper Gravel	Cold	Late Saalian	6
		Warm	Intra-Saalian	7
	Aveley Silts and sands		Stanton-Harcourt Interglacial	
	Mucking Lower Gravel	Cold	Intra-Saalian	8
Lynch Hill/Corbets Tey	Corbets Tey Upper Gravel	Cold	Intra-Saalian	8
	Purfleet Silts and sands	Warm	Intra-Saalian	9
	Corbets Tey Lower Gravel	Cold	Early Saalian	10
Boyn Hill/Orsett Heath	Orsett Heath Upper Gravel	Cold	Early Saalian	10
	Swanscombe Interglacial deposits	Warm	Hoxnian	11
	Orsett Heath Lower Gravel	Cold	Late Anglian	12
Black Park	Cannot be recognised separately in this area	Cold	Late Anglian	12
Lowestoft	Hornchurch Till	Cold (full glacial)	Anglian (Lowestoft Stadial)	12

(Adapted from Bridgland 2006).

Uniclinal shifting

Rivers in south-east England show a relationship between bedrock type and patterns of fluvial migration and terrace preservation (Bridgland 1985). Those in the London Basin with an extensive flight of aggradation terraces on one side of their valley and not on the other include the Kentish Stour, the lower Medway (Coleman 1952) and the Lea (Murton and Belshaw 2011; Sherlock and Pocock 1924). Terrace runs may also shift across the present valley axes - e.g. the Thames Kempton Park Gravel Terrace, on

Table 5.3 Correlation of the Quaternary terraces of the Middle/Lower Somme Valley with the MIS record

Terrace formation Middle/Lower Somme	Age	δ
Etouvie (I)	Late Saalian/ Eemian	6/5e
Montières (II)	Intra-Saalian 2	7
Argoeuves	Saalian	8
Epinette (IV)	Saalian/Intra Saalian 1	10/9
Garenne (V)	Glac C/ Cromerian IV	12/11
Fréville (VI)	Glac B/ Cromerian III	14/13
Renancourt (VII)	Glac.A/ Cromerial II	17/16
Saveuse (VIII)	Glac. A	18/17
Grace (IX)	Cromerian I	19
Grace-Autoroute (X)	Bavelian	25/24

(Adapted from Antoine et al. 1998; Antoine et al. 2010)

the right bank at Maidenhead, is on the left bank downstream at Iver (Lewin and Gibbard 2010). All these rivers are in areas of clayey Tertiary bedrock. Unilateral terraces also survive in the lower Somme valley (Antoine *et al.* 2000) and the river Maas near Maastricht (Westaway *et al.* 2002). In areas with sandy bedrock terrace preservation is equal, albeit sporadic, on both sides of the valleys (Bridgland 1985).

Where they flow over Chalk, however, rivers remain entrenched in gorge-like valleys – e.g. the Goring Gap, Oxfordshire. These Chalkland 'gorges' are often only a few hundred metres wide, rather than the several kilometres typical of river valleys in the lower reaches of the Hampshire and London Basins (Westaway *et al.* 2006). Terraces are created in areas of softer rock, where the valley is wider and the river has been able to migrate laterally. On Chalk, rivers probably occupied the same position for much of the time as it was easier to remove former accumulations than to erode a wide valley (Allen and Gibbard 1993; Vandenberghe 2010).

For example, the most extensive staircase of Medway terraces survives on the Hoo peninsula, an area of London Clay. About 10km to the south, the Medway flows through the Chalk of the Medway Gap in the North Downs and is confined to a steep-sided narrow valley with few surviving terrace remnants (Bridgland 2003). In the area around Dorchester, where the Frome flows over Chalk its valley is narrower and has steeper sides than its downstream counterpart, while on the Chalk above Mottisfont the River Test is confined to a straight narrow valley with only small terrace gravel remnants, changing once it reaches the Tertiary sands and clays (Hosfield 1998). As a result, valleys lacking the terrace sequences which have produced the bulk of the British Lower-Middle Palaeolithic archaeological record are typical of Chalkland river systems, including parts of the Middle Thames, Lower Thames, Kentish Stour, Medway, Darent and Upper Lea (Bridgland 1985). Similar valleys, almost devoid of terrace sequences, also characterize the Chalk outcrops of river systems in northern France (Gibbard and Allen 1994; Gibbard and Lewin 2003; Vandenberghe 2010).

Uplift

The significance of landscape uplift for my research lies in the role it played in the formation of river terraces. Despite a few detractors (Gibbard and Lewin 2009; Hancock and Anderson 2002; Martins *et al.* 2010) there is general consensus that it is the interaction between regional uplift and climate which is responsible for terrace staircase and raised beach formation (Antoine *et al*. 2000; Bridgland 2000; Bridgland 2006; Bridgland *et al*. 2004; Bridgland and Westaway 2008; Bridgland and Westaway 2014; Maddy 1997; Rose 2006; Westaway et al. 2002) and the systematic gorge incision revealed by sequences of river terraces has long been regarded as evidence for Quaternary uplift of the land surface. Throughout much of the Pleistocene, northern France and southern England apart from eastern East Anglia experienced differential uplift, possibly as discontinuous pulses, of at least 250m and possibly up to 400m (Jones 1999b; Preece *et al* 1990; Westaway *et al*. 2002). Estimated post-Early Pleistocene uplift in southern Britain increased eastward, from 55m in west Cornwall to ~80m in the Hampshire Basin, rising to ~180m in the London Basin (Lagarde *et al.* 2003; Westaway 2010; Westaway *et al*. 2006),

There was an apparently world-wide increase in uplift rates in response to the start of 100ka Milankovitch forcing (Bridgland and Westaway 2008). Using a simple linear model based on the assumption that terrace height equates to uplift, Maddy (1997) calculated an uplift rate of seven centimetres per thousand years for the terrace sequence in the Upper Thames Valley. This figure held good when tested against terraces in the Wye Valley and the Hampshire Avon and was also in good agreement with Bowen's (1994) seven centimetres per thousand years uplift rate for the Sussex raised beaches, Preece *et al.'s* (1990) uplift rate of five to15.5 centimetres per thousand years for the raised beach deposits of the Isle of Wight and southern England and Veldkamp and van den Berg's (1993) average, also based on river gorge incision, of six centimetres per thousand years during the Pleistocene. The uplift rate of the Seine and Somme has also been five to six centimetres per thousand years since the end of the early Pleistocene, comparable to that in the Yonne valley (Antoine 1994; Antoine *et al*. 2000; Antoine *et al.* 2003; Antoine *et al.* 2007; Westaway 2001). This suggests that regional uplift at this uniform, time-averaged rate has been widespread.

Maddy's equation of terrace height with uplift rate has been criticised (Brocard *et al.* 2009; Kiden and Törnquist 1998) on grounds that other factors, such as variations in erosion rates, could be involved in observed changes of relief and that comparisons with raised beaches, which can potentially provide true uplift rates, are invalid. However, uplift is also required to explain the raised beach staircases, while fluvial, marine and karstic data can all indicate uplift under appropriate conditions. They can, therefore, reasonably be tested against each other especially where, as in Sussex, direct relationships can be demonstrated between the marine and fluvial archives (Bridgland *et al.* 2004; Westaway 2010). Isostatic response to interfluve erosion may be significant in southern England, meaning global net uplift rate may be substantially less than local gorge incision Maddy (1998).

The premise that river terrace height provides a record of fluvial incision in response to progressive and approximately constant uplift appears to be valid in unglaciated parts of Northwest Europe (Bridgland 2003) and has enabled dated river terraces to be used to calculate time-averaged incision rates (Bridgland and Westaway 2008). Periods of decreased and increased

uplift probably occurred, meaning estimates of average uplift rate are only broadly indicative (Bowen 1994) but nonetheless, deviations from them are small (Stemerdink et al. 2010, 448).

Evidence exists for a substantial pre-MIS5e incision event representing a minimum vertical level change of 14m in the Lower Thames valley (Gibbard 1995b) and ten terraces have been identified for the Kentish Stour (Coleman 1952). Based on the height of each of these terraces above the present Stour, they have been dated to 650ka at Fordwich (46m), 410ka at Sturry (30m) and 140ka at Chislet (10m) and correlated respectively with the Lynch Hill/Corbets Tey Gravel of the Thames for Sturry and the Taplow/Mucking Gravel for Chislet. The Fordwich Gravel, was probably MIS12 or older (Bridgland *et al.*1998). While the Middle Stour cut down through Chalk without much easterly migration, the Lower Stour moved largely and freely eastwards, forming the main terrace flights (Coleman 1952). Terrace sequences have also been established for the Mole and the Medway.

In Hertfordshire some of the, probably MIS10-MIS6 and MIS5d-MIS2, river gravels form recognisable low terraces. In the Stort and Ash valleys they occur at one to two metres and three to four and a half metres above the modern floodplain (Catt 2010,176). In the Lower Lea valley two terraces have been identified on the western bank (Bridgland 1985; Sherlock and Pocock 1924) the upper of which, seven metres thick, correlates with the Taplow Terrace of the Thames (MIS8-6). The lower terrace, four to five metres thick, correlates with the Kempton Park Terrace (MIS5). Traces of the lower terrace are also found on the eastern bank.

Fluvial sequences within the Sussex river valleys are less extensive than those of the Solent system and the number of preserved river terraces/river aggradations decreases from west to east across the Sussex Coastal Plain. The number of identified terraces and/or fluvial aggradations drops steadily from a high of >11 within the eastern Solent and along the River Test (Westaway *et al.* 2006). The river Meon has seven terraces, the Arun six, the Ouse five (Thurrell *et. al.*1968) but the Adur and Cuckmere only three (Bates 1993; Bates 2001; Lake *et al.* 1987; Young and Lake 1988). This apparent decrease may be because of differential uplift rates across the plain, although the age of some of the data, length of river systems and

possibly the influence of differing bedrock geologies within the river hinterlands may all play a role (Bates 1993).

The only dating evidence for the terraces of the Arun is the presence of Palaeolithic artefact assemblages (Bridgland *et al.* 2008). However, they are interspersed within the Sussex raised beach staircase (Table 5.4) the deposits of which are reasonably well constrained by both biostratigraphy and geochronology (Bridgland *et al.* 2004; Bridgland *et al.* 2008).

Table 5.4 Correlation of Sussex river terraces and raised beaches

Sussex coastal plain	Arun Valley	Height above present Arun river	Adur Valley	Stage	MIS
	Buried channel deposits		Buried channel deposits	Late Devensian	5d-2
	First Terrace	0-1.5m	First Terrace	Late Devensian	
	Second Terrace	1.5-5m	Second Terrace	Late Saalian	6
Pagham Raised Beach				Ipswichian	5e
	Third Terrace	6-9m	Third Terrace		
Brighton-Norton Raised Beach				Intra-Saalian	7
	Fourth Terrace	11-15m			
	Fifth Terrace	12-21m			
?Initial occupation Brighton-Norton Platform					9
	?Sixth Terrace?	27-30m			
Aldingbourne Raised Beach					11
Goodwood-Slindon Raised Beach/Portsdown Road Raised Beach?				Pre-Anglian/post-Cromerian *(Sensu stricto)*	13

(Based on Bridgland et al. 2004 and Woodcock 1981).

The relationship between climate and river incision/aggradation is complex and variable, according to the different parts of the river courses. The evolution of the different rivers of the English Channel region reflects their response to climate change, local geological structure and long-term tectonic activity (Antoine *et al*. 2003; Vandenberghe 2003). Variability in

fluvial incision rates undoubtedly occurred from river to river and in response to short-term climatic fluctuations. On Chalk bedrock, however, incision is likely to have been deeper - for example, the Arun gap through the South Downs has erosion flats at 61m, 40m and 24m OD (Kirkaldy and Bull 1940).

Nevertheless, given the likelihood of long-term equilibrium in river terrace formation (Brocard et al 2003) and using identified incision rates for rivers within the study region, including the Somme, Middle/Lower Thames (Bridgland 2010, fig. 1e) and Hampshire Avon, I have assumed an incision rate of 10m per climatic cycle for the purpose of my research, based on the median of all the known figures.

d) <u>The impact of fluctuating sea-levels</u>

Since 800 ka the build-up and decay of ice-sheets in synchrony with ~100 ka climatic cycles has also driven changes in global sea-level, with maximum amplitudes of 120-140m, a global highstand of ~100-130m OD and an 'average' Quaternary sea-level ~55m below present (Bellamy 1995; Bennett 1995, 174; Funnell 1995; Gallup *et al*. 1994; Gibbard 1995a; Lambeck *et al*. 2002a; Porter 1989; Thompson and Goldstein 2006). For more than two thirds of this time sea-level ranged between ~-25 and -85m and is unlikely to have been glacio-eustatically higher than the present by more than a few metres at any time (Porter 1989; Shackleton 1987).

The Last Glacial Maximum figure of six to nine metres mean sea-level rise is frequently used as a baseline for estimating isostatic uplift rates (Vasskog et al. 2015), despite the fact that accumulating evidence reveals a complex pattern of change throughout the Pleistocene (Lambeck *et al*. 2002a; Lambeck *et al.* 2002b). Local scale issues also have a bearing, meaning it cannot safely be assumed that a globally averaged sea-level value can be used to correct local sea-level records, or that the difference between the two is negligible (Creveling *et al.* 2015; Shennan *et al.* 2002).

Coastline features are particularly important markers of previous sea-level positions in southeast England and northwest France, both subaerial features such as the modern coast and older, higher-level raised beaches, estuarine and marine sediments and similar features below modern sea-level (Gibbard and Lautridou 2003; Ward et al. 2016). The '100 foot' (Goodwood) and '25 foot' (Selsey) raised beaches, for example, are relict

indicators of sea-level during MIS11 and MIS5e (Robinson and Williams 1983; Gallup *et al*. 1994).

The impact of sea-level change on fluvial systems is difficult to calculate because other variables, including rate, amount and direction of change, river character and dynamics and erodibility of the sediment source area, also play a part and incision owing to sea-level fall may be restricted in many areas by shallow off-shore gradients. While sea-level fluctuation can be an important local driver in the lower reaches of rivers debouching onto narrow continental shelves it is widely agreed (Antoine *et al*. 2000; Bridgland and Westaway 2014; Leopold and Bull 1979; Maddy 1997; Schumm 1993) that the effects of sea-level change were generally moderate, did not extend far up-basin and could at least partly be accommodated by course lengthening or shortening, with little imperative for aggradation or incision. When sea-level falls below the edge of a wide continental shelf and retreats down the continental slope then channels will incise and valleys will form, with no marked break of slope at the present coastline – e.g. the submerged valleys of the Sussex rivers Arun, Adur and Ouse (Bellamy 1995).

Breaching of the Weald-Artois Chalk ridge and subsequent insularity

The formation of the Strait of Dover as a result of the initial breaching of the Weald-Artois Chalk ridge connecting southeast Britain and northwest France is generally accepted as having occurred during late MIS12 (Ashton, 2018; Funnell 1995; Gibbard 1995a; Meijer & Preece 1995; Smith 1985; Sutcliffe 1995). This breaching and the subsequent formation of the palaeovalley network has been variously credited to fluvial erosion during late Quaternary sea-level change, glacial erosion, ice-sheet melting, tidal scouring or erosion by catastrophic flooding from an immense glacial lake in the southern North Sea (Auffret and Alduc 1977; Garcia-Moreno *et al.* 2019; Gupta *et al.* 2007; Smith 1985; Toucanne et al. 2009; Toucanne *et al.* 2010; Westaway and Bridgland 2010). The possibility has also been raised that at least two such ‘megafloods’ occurred between 450ka and 180ka, the first seriously reducing the ridge in width and height but not removing it entirely. The second, probably at the end of MIS6, removed it completely fully connecting the North Sea and English Channel drainage (Gibbard 2007; Gibbard & Cohen 2015). The ‘catastrophic’ explanation has,

however, been challenged (Toucanne *et al*. 2009; Toucanne *et al.* 2010; Westaway and Bridgland 2010). Hijma *et al.* (2012) have proposed that during MIS11 to MIS7, although the Scheldt and Thames flowed through the Dover Strait, the Rhine continued to flow north-west into the North Sea. Despite possible overtopping by shallow marine waters in places during some sea-level highstands, the resultant watershed across the Southern Bight formed a land-bridge between East Anglia and continental Europe, providing a narrow routeway into Britain until the Dover Strait was further enlarged during MIS6.

The breaching of the Weald-Artois anticline was of utmost importance to the human occupation of Britain as from that point onward the potential existed for Britain to become an island given sufficient sea-level rise during interglacial periods (Ashton 2016; White & Schreve 2000). Based on the $\delta^{18}O$ record in planktonic foraminifera, sea-level high-stands comparable to modern sea-level occurred during MIS7.5, MIS 7.1 and MIS5e (when it peaked about five and a half and nine metres above present). Sea-level low-stands of ~ -120m occurred during MIS10.2, MIS8.2, MIS6.2 and MIS2.2 (LGM), with an intermediate sea-level of -30± 20m during MIS6.5. (Lea *et al*. 2002; Long *et al.* 2015). After MIS5 sea-level oscillated rapidly (by ~10-15m every 4000 years) and at the onset of the LGM fell ~30-~40m within 1,000-2,000 years (Lambeck *et al.* 2002a). Connection to the mainland therefore remained the default status throughout the Pleistocene (Bridgland & D'Olier 1995), with insularity occurring only during the latter part of MIS11, part of MIS9 and most of MIS7 (White and Schreve 2000) and MIS5e. Nevertheless, the breaching of the Weald-Artois anticline had profound implications for the palaeogeography of the region and the ease with which early humans, flora and fauna could gain access to Britain from continental Europe. Britain's insularity during subsequent interglacials resulted in significant differences in the presence or absence of particular faunal species, allowing the construction of a diagnostic scheme of Mammalian Assemblage Zones (MAZ) based on evidence from the Lower Thames and correlated with the MIS record. This provides a framework for correlation between geographically distant localities and different types of depositional environment (Bridgland and Schreve 2001; Schreve 2001) and allows the dating of archaeological sites that would otherwise be undatable, or datable only on the basis of the technology present.

Britain's changing status in respect of connection to or isolation from Continental Europe has also been identified (by Ashton *et al.* 2011; Ashton *et al.*2015; Ashton *et al.* 2016; Ashton and Hosfield 2010; Scott and Ashton 2011; Scott *et al*. 2010; White and Schreve 2000) as the cause of the demographic and technological changes visible in the Middle Pleistocene archaeological record of southeast Britain (*cf.* Chapter Three).

iv) Periglaciation

Permafrost

At times during the Quaternary 40% of the world's land area has been periglaciated (Lowe and Walker 1997). Permafrost is ground in which the temperature remains below 0^{o} over at least two consecutive years (Busby *et al.* 2013) and multiple periods of widespread permafrost development in Britain have been identified (Ballantyne and Harris 1994). The effects of periglacial processes are particularly marked on the Chalklands of southern England (Goudie 1990) and molluscan data from solifluction sequences in Sussex, the Isle of Wight and Kent suggest that southern English periglacial landscapes consisted of damp steppe grassland and marsh (Wilkinson 2007). In England, the boundary between continuous and discontinuous permafrost has been placed close to the present coast of Kent, Sussex and Hampshire at times between MIS5d and MIS2 (Huijzer and Vandenberghe 1998). During the LGM permafrost developed as far south as the Paris Basin, where it is estimated to have reached a depth of ~300m (Westaway and Bridgland 2010), although its extent and thickness in France is strongly debated (Murton and Lautridou 2003).

Solutional lowering and erosion of the interfluves

Erosion is the dominant process operating on most land areas (Gibbard & Lewin 2016) but chemical weathering has a greater effect on the Chalk because Chalk's exceptional permeability allows rainwater to percolate down cracks and fissures, dissolving away the rock (Smith and Atkinson 1976; Williams and Robinson 1983). Although the different strata of downland Chalk vary in permeability (Goudie 1990), it is surprisingly resistant to weathering and erosion in warmer conditions (Williams and Robinson 1983). While up to 250m of Chalk was removed from the London

Basin through pre-Eocene erosion, this figure probably rose to >450m on the Weald (Jones 1980).

Quantifying the relationship between substrate erodibility, weathering and topography is extremely difficult, because resistance is non-uniform across the landscape and the main erosional agents – rivers, debris flows, landslides and glaciers – operate at different spatial and temporal scales (Goudie 2016). Assessing the degree to which the Chalklands have been affected by solutional lowering and erosion is, therefore, one of the most perplexing problems in analysing the evolution of southern England (Jones 1981) and it is now impossible to distinguish the effects of each successive cold period, only the cumulative effect of all periods (Williams 1968).

Despite these difficulties, solutional lowering has been put at 13-61mm per thousand years (Jones 1981; Sommé 1988; Sperling *et al.* 1988; Williams and Robinson 1983) the principal control being mean water hardness (Smith and Atkinson 1976). Jones (1999b) calculated Quaternary denudation rates of 20-145m per thousand years for the South Downs and 23-88m per thousand for the North Downs. However, while potentially amounting to >200m during the Quaternary, the gentle nature of this lowering (Catt and Hodgson 1976) means the actual land surface may have altered little since the Cromerian (Catt 1986; Douglas 1976; Scott-Jackson 2000; Wymer 1999). The most striking relief features attributable to differential weathering and erosion are the secondary escarpments of the South Downs and Hampshire Basin (Williams 1980). On the South Downs this is most clearly developed between the Arun and Adur river gaps, where it takes the form of north-pointing prow-like hills such as Harrow Hill, Black Patch Hill and Cissbury Ring (Small and Fisher 1970).

Surface erosion would have cut rapidly though the superficial deposits into the Chalk and once an interconnecting system of valleys was established, the exposed Chalk of those valleys was more susceptible to solifluction than the Plateau Drift- and Clay-with-flints-protected interfluves. Negligible interfluve erosion rates have been demonstrated, based on calculations of fluvial sediment budgets for the Thames and other rivers draining into the southern North Sea. They can reasonably be assumed where river gorges are narrow compared with the interfluves, as is the case on the Chalk Downs on which this study focuses (Westaway 2001; Westaway et al.

2002). The interfluves probably remained fairly stable throughout subsequent warm and cold periods (Catt and Hodgson 1976), undergoing only minor erosion or deposition since the Cromerian (Catt 1986).

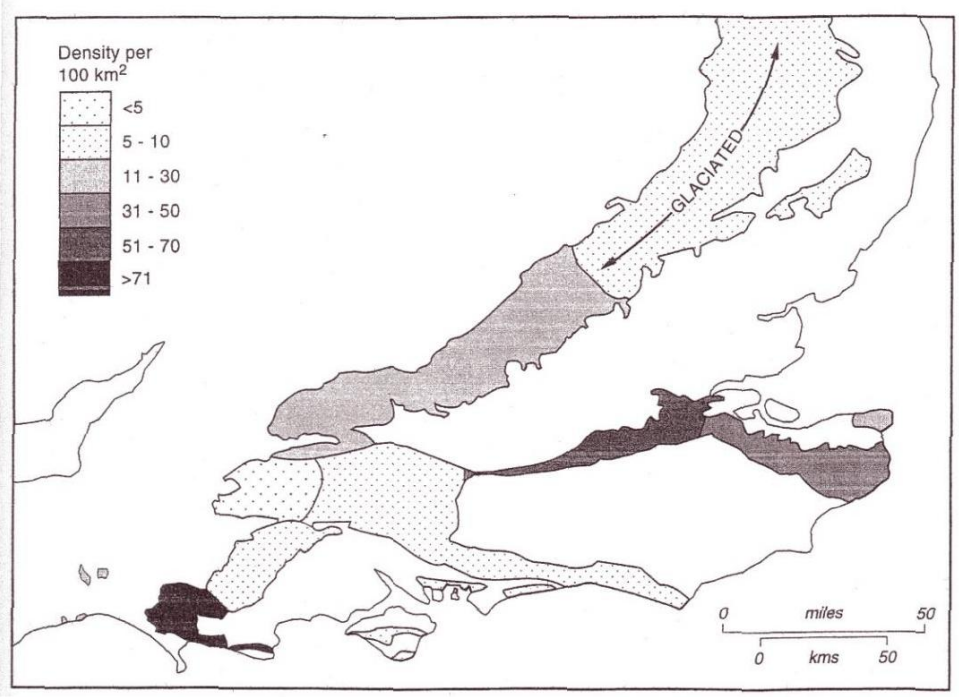
Doline formation

Solution features in the Chalk were initiated, developed and reactivated under Pleistocene periglacial conditions as a result of meltwater which, owing to its low temperature, had an enhanced capability of dissolving CO_2 (Higginbottom & Fookes 1971).

Formed when water runs off impermeable Palaeogene deposits onto permeable Clay-with-flints or Chalk and with preferential development on the Upper Chalk (Scott-Jackson 2000; Sperling *et al*. 1977), the major controls on doline distribution are the lithology of the Chalk itself and the presence or absence of overlying Tertiary beds or superficial deposits. Relatively high concentrations occur where Palaogene deposits are most extensive (the London Basin) and erosion surfaces best preserved (the London Basin and the extreme west). Low densities are recorded where superficial deposits are generally thin and erosion surfaces relatively poorly preserved because of dissection (Jones 1999a; Sperling et al. 1977). On the South Downs escarpment, the density of sinkholes (dolines formed by ground subsidence rather than solution) averages 15 per 100km^2 (McDowell *et al.* 2008, 279). On the North Downs overall, doline density is 47 per 100km^2, concentrated in Surrey and the West Kent Downs which have 63 dolines per 100km^2 (Edmonds 1983). The Chilterns have an overall density of solution features (including sinkholes and solution pipes) of 22/100km^2, >1000 of which lie in the western Chilterns (Worsley 2016).

Sub-circular in plan, dolines may be tens to hundreds of metres in diameter and up to tens of metres deep (Williams 2004). Their depth is probably constrained by the level of the water-table, which represents the base of effective dissolution (Sperling et al. 1977). Collapsed solution hollows may trap and preserve primary context Pleistocene palaeosols and archaeology, as at Caddington and Revelles les Terres Sellier.

Fig. 5.11. Density of solution features on the Chalk of southern England



(Reproduced from Jones 1999a Fig. 9)

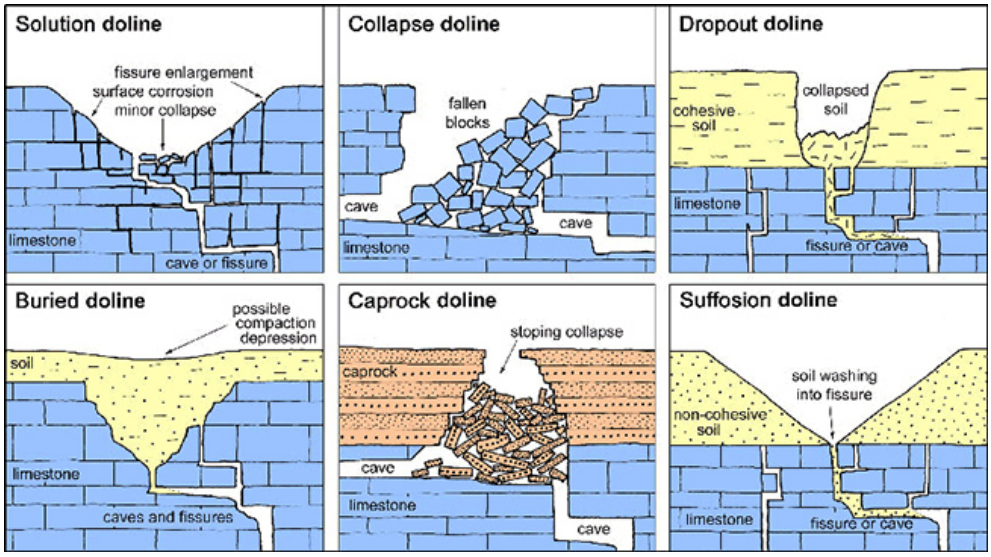
Solifluction

Surface erosion did occur, however, when an unprotected Chalk surface was rendered impermeable under periglacial conditions (Catt and Hodgson 1976), with a potential high peak of sediment transport on hillslopes during the glacial-interglacial transitions of the Quaternary (Bovy *et al*.2016). Even on gentle slopes the weathered Chalk would have been easily removed by sheetwash and solifluction, although the sunnier south- and west-facing slopes probably thawed to greater depths, leading to different rates of weathering and erosion and the formation of asymmetric dry valleys (Williams 1980). Except where deposited on an extensive plain, the volume of solifluction and sheetwash deposits close to Chalk outcrops can be seriously misleading about the amount of periglacial erosion, as much may have been washed away into connecting fluvial systems.

In all periglacial areas there is a surface layer of ground, the active layer, which repeatedly freezes and thaws with the seasons. Unprotected Chalk is highly frost-susceptible when saturated, meaning that measurable amounts of weathering would have occurred, eventually pulverising the entire active layer. Repeated freezing and thawing resulted in mass movement of the former active layer, in some areas because of solifluction and in others to

the sliding of masses of intact soil over the former permafrost table (Ballantyne and Harris 1994). On the South Downs, frost-shattered Chalk up to 2.5m deep underlies at least 80% of the land-surface and even on comparatively gentle slopes this shows signs of downhill movement attributable to frost creep or solifluction (Williams 1986). The most important periglacial slope deposit on the Chalk of southeast England is 'Coombe Rock', a cemented silty mud containing chalk and flint clasts. Its considerable volumes are proof of severe periglacial erosion, which has fundamentally shaped hillslopes in southern England (Murton and Giles 2016).

Fig. 5.12. Doline formation



The solution and buried dolines illustrate the two stages of the process described above. (Reproduced from www.bgs.ac.uk/caves/sinkholes/home.html with the permission of the British Geological Survey @UKRI. All rights reserved).

Repeated freezing and thawing of the active layer also results in the formation of distinctive, small-scale landforms and sedimentary structures, including cryoturbation (the formation of patterned ground forms in response to mixing by ice) and periglacial slope deposits or head. (Ballantyne and Harris 1994). Relict patterned ground features in southeast Britain and northern France created by periglacial processes include ice-wedges, soil wedges, and cryoturbation structures such as involutions, apparent in Chalk only when overlying materials are present (Williams 1965). An involuted layer within the upper 0.5-2.0 m of Pleistocene sedimentary sequences is widespread in lowland England, where it forms a cryostratigraphic marker horizon commonly attributed to the Late Devensian (MIS2). This horizon is extensive and well-developed on the

Chalklands of Kent and Sussex (Ballantyne and Harris 1994; Murton and Giles 2016).

Fig. 5.13a. Involutions/cryoturbation in Pit A, Caddington, illustrated by Worthington Smith.

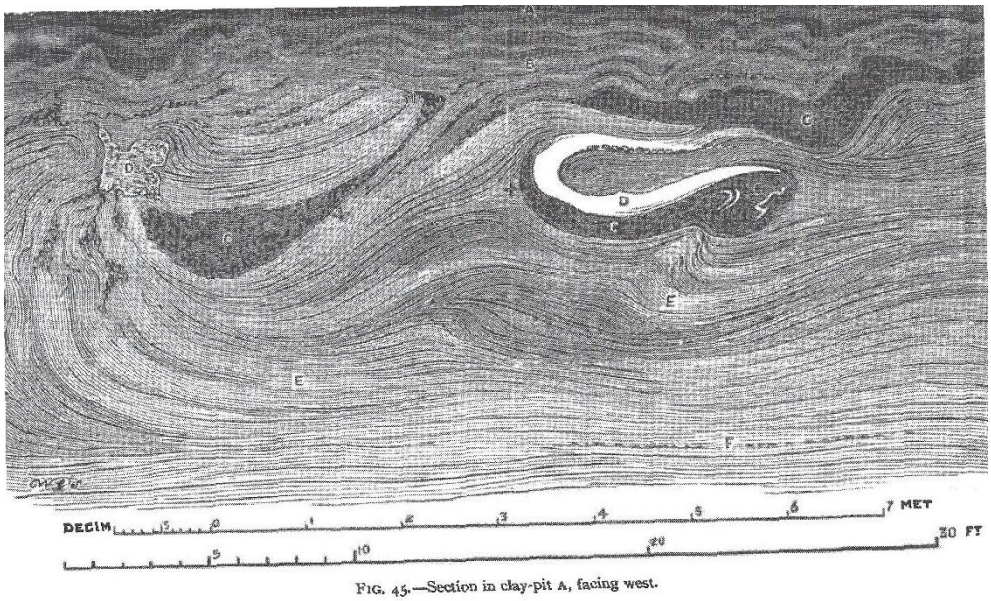


FIG. 45.—Section in clay-pit A, facing west.

A - surface material; B - ochreous brown clay with small pebbles; C - contorted flint gravel/stony clay; D - white-grey clay/boulder-clay with whitish-ochreous flints and flint pebbles; E - mixed brickearth and red clay; F - old land surface with fresh Palaeolithic flakes. (Reproduced from Smith 1894 Fig.45).

Numerous periglacial features, including wedge and cryoturbation features have also been observed in northern France, with significantly increased numbers of features being described following the development of rescue archaeology (Bertran et al 2014). Periglacial structures *per se* have not been dated but loess chronostratigraphy provides a good marker for dating, (Bertran *et al.* 2014).

Cambering (the large-scale flexing and stretching of the hard caprock over the upper parts of valley-side slopes) causes deep fractures, or gulls, sometimes filled with sediments (Ballantyne and Harris 1994) which may also preserve archaeological or palaeontological remains – e.g. at Beedings, West Sussex, the only open air locality in the British Isles where possible separation and stratigraphic succession of Late Middle Palaeolithic and Early Upper Palaeolithic material has been demonstrated (Pope 2008; Pope *et al.* 2013).

Fig. 5.13b Dissolution pipes in Chalk containing Plateau Drift and lined with darker brown Clay-with-flints *sensu stricto*, M25 Chorleywood (TQ040 957)

(Photograph © John Catt. Reproduced from Catt 2010 Plate 27)

Formation and development of the dry valley networks

The dry valley is the landform most associated with the Chalk Downs (Goudie 1990; Jones 1981; Smith and Atkinson 1976). During the Neogene, a master-network of widely-spaced valleys existed, probably cut by stream action as a result of the higher water table at the time and with few tributaries. At this stage both interglacial and periglacial erosion of valleys might have been important (Williams 1980).

Present dry valley patterns have existed since at least the Middle Pleistocene, with later periglacial erosion deepening them and modifying their cross-profiles, primarily during MIS10 to-MIS6 and MIS5d to MIS2. The dry valleys would, therefore, have impacted significantly on early human upland landscape use, at least during the later stages of the Pleistocene. In addition, steepening dry valley slopes would have caused increasing periglacial solifluction, potentially carrying artefacts released from the plateau-edge down into dry valley bottoms. This must be understood when interpreting artefact distribution maps.

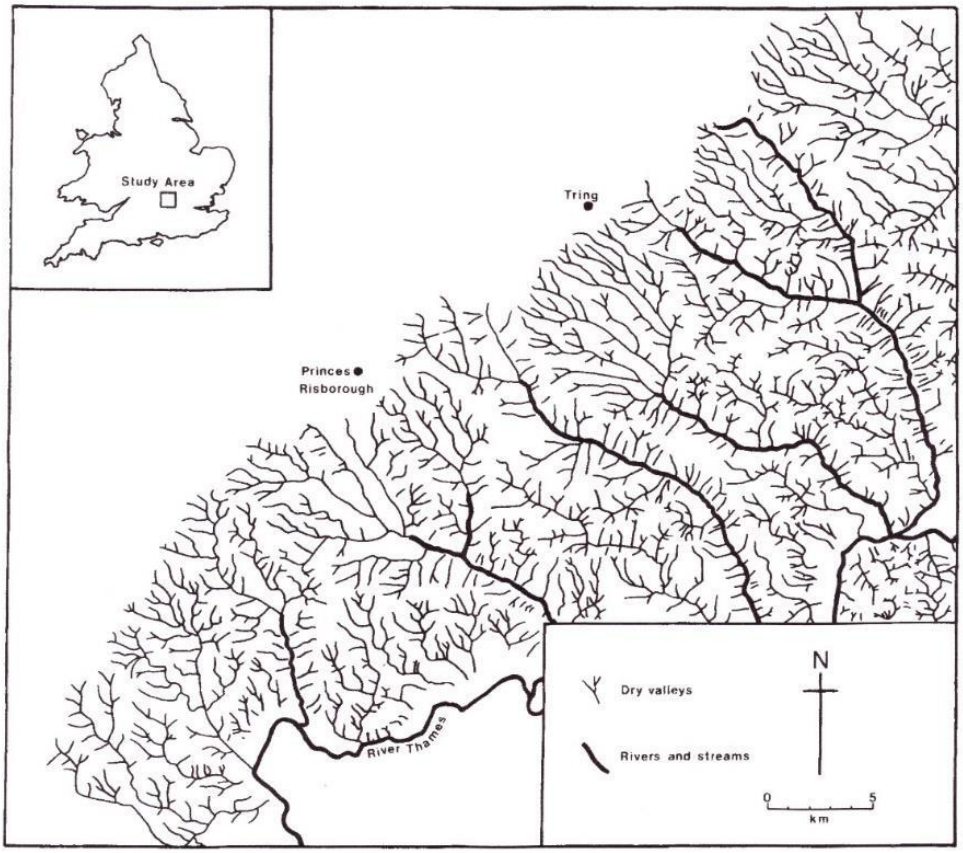
Dry valley formation has been variously attributed to periglacial streams (Reid 1887), meltwater from local ice-caps (Bull 1940), lowering of the

water table (Fagg 1923 cited by Catt and Hodgson 1976; Sparks 1949), past periods of wetter climate and headward erosion/spring-sapping (Sparks and Lewis 1957; Small 1965). Although spring sapping would have been of minimal importance under permafrost conditions, the periglacial and spring sapping hypotheses are not mutually exclusive (Goudie 1990; Small, 1965). Moffat and Catt (1986) consider it unlikely that periglacial processes actually initiated any part of the dry valley network and for Jones (1981) the majority were probably initiated before the onset of periglacial conditions. There is, nevertheless, a general consensus that periglacial processes helped shape the dip slope valley network.

There are two main types of dry valley, dip-slope and scarp-face. Large dip-slope valleys contain major drainage lines and valley patterns, with numerous small tributaries feeding into the large valleys to produce asymmetrical tributary patterns (French 1972). Morgan (1971) identified a network of two types – valley segments in equilibrium, possible relics of the late Tertiary system lying above 150m; and those in disequilibrium, lying below 150m and formed during Pleistocene periglacial episodes.

Most dipslope valleys are 0.2 to 1.00 km wide, with gently to moderately sloping sides (9-15^{o}) and heads terminating gradually at various levels on the plateau surface (Catt 2010). Their flat floors are due, probably, to partial infill with Late Devensian Coombe Deposits, the underlying Chalk bedrock being V- or U-shaped, suggesting previous development by fluvial erosion (Sparks and Lewis 1957; Catt 2010). Dip-slope dry valleys are often asymmetrical in cross-section, the result of periglacial stream erosion in the valley bottom combined with solifluction and creep acting on the gentle slope and freeze-thaw processes on the steeper slope. Dry valley asymmetry with the steeper slope oriented southwest or west is regarded as ‘normal’ for western Europe and the asymmetry in Chiltern dry valleys is directly comparable to that of the dry valleys of northern France (French 1972). Most of the dry valleys of the Somme have the same clear asymmetry, with one steep south-west facing chalky slope and a gentler north-east facing slope where the loess deposits are thickest.

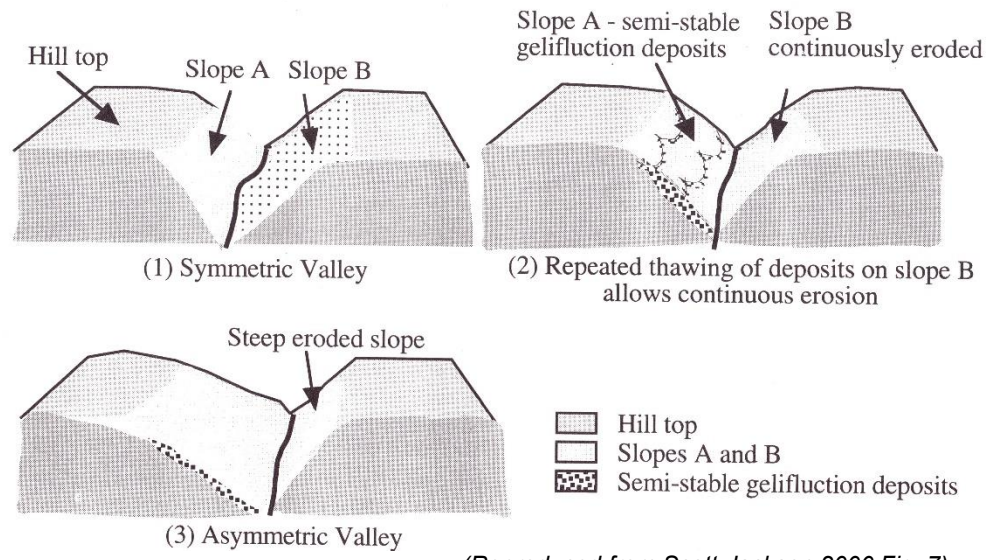
Fig. 5.14 The dry valley network of the Chilterns



(Reproduced from Moffat and Catt 1986 Fig.1)

Asymmetry begins to develop when slope angles are between seven and nine degrees and ends when the steeper slope reaches its maximum angle of 19º to 22º and there is equilibrium between debris arriving from both valley sides and the erosive powers of a basal stream. The process then begins to reverse, steadily reducing asymmetry until it eventually disappears (French 1972). This sequence is applicable to all areas of the Chalk of southern England with 'normal' southwest- or west-facing asymmetry, including the Chilterns, North Downs between Canterbury and Folkestone, North Wiltshire and North Dorset, but not to the randomly-oriented asymmetry of south Hampshire or the primarily North-facing asymmetry of Salisbury Plain (French 1972). Williams (1980) calculated that 14% to 38% of valley volume on the Chilterns, Marlborough Downs and North Downs may have been eroded asymmetrically under periglacial conditions.

Fig. 5.15. Asymmetric dry valley development.



(Reproduced from Scott-Jackson 2000 Fig. 7).

Scarp-face valleys are more striking than those on the dip-slope, varied in form and ranging in length from a few hundred metres to several kilometres – e.g. the Chiltern escarpment valleys near the Goring Gap, Oxfordshire (Jones 1981). At the north-eastern end of the Chilterns scarp-face dry valleys are shorter and narrower, with steep sides (up to 30°) and steep

Fig. 5.16 The scarp-face dry valley at Pegsdon, Chilterns (TL 119 301)

View taken from above, looking down-valley with the scarp-face behind the photographer. The 90° bend to the right is clearly visible. (Photograph © L. Blundell).

Fig 5. 5.17. A more typical straight scarp-face dry valley at Barton Springs, Chilterns (TL 088 295).

(Photograph © L. Blundell).

(10° to 20°) abrupt heads close to the scarp crest (Catt 2010). Although usually straight, a few dry valleys, such as the scarp-face valley at Pegsdon, Hertfordshire (TL 1029) have sharp (90°) bends (Jones 1981; Sparks and Lewis 1957).

On the South Downs, too, scarp-face valleys can be spectacular, steep-walled trenches as much as 70-90 metres deep – e.g. Rake Bottom, Petersfield and Devil's Dyke, Brighton (Small 1965). On dip-slopes, springs commonly break out at points where the water table intersects with the valley floor but on the scarp-face, springs tend to issue at certain well-defined horizons in the rock (Small 1965; Sparks and Lewis 1957) – e.g. Devil's Dyke, near Brighton and Barton-le-Clay, Bedfordshire, in the central Chilterns (Fig. 5.22). At the latter, the flow of water through the permeable ZigZag Chalk and Totternhoe Stone is held up by the underlying relatively impermeable West Melbury Chalk Marl. It then travels along fissures in the Totternhoe Stone to emerge as springs at its base.

Fig.5.18. Barton Springs (TL 080 290).

Springs issue from the scarp face at the Totternhoe Stone boundary between the Zig Zag and West Melbury Marly Chalk. (Photograph © L. Blundell).

In the early Quaternary the water table in the Chalk was much higher than at present and the valleys not as deeply excavated. The major dry valleys became successively drier from the headwaters downward as the water table fell during the Pleistocene (French 1972; Gregory 1976; Morgan 1971). A rise in the water table during temperate wet periods in the Late Devensian and Holocene may have established temporary streams in some of the valleys previously cut by periglacial erosion (Catt and Hodgson 1976; Williams 1980). Interglacial and post-glacial erosion is likely to have been negligible, owing to the low level of the water table (Catt and Hodgson 1976; Moffat and Catt 1986; Williams 1980; Williams and Robinson 1983).

The strongest evidence that periglacial processes played an important role in dry valley formation is probably their Coombe Rock deposits (Ballantyne and Harris 1994) which must have originated from the plateaux and dry valley slopes. Genetically equivalent to Head and sometimes interbedded with irregular silty and clayey layers, including Clay-with-flints *sensu stricto* and loess (Catt and Hodgson 1976), these deposits generally thicken down-valley and are deepest on the valley floor. Low-gradient fans of chalky debris extend beyond the mouths of some escarpment valleys – e.g.

near Brook, Kent (Ballantyne and Harris 1994) - and dip-slope valleys may also contain considerable depths of Chalk 'Head'. Some dry valleys, however – e.g. the Cuckmere valley at Seven Sisters, Sussex and Stonehenge Bottom, Wiltshire - have no colluvium (Allen 1991).

A wide range of evidence supports the periglacial hypothesis of dry valley formation. However, given the great diversity of dry valley types, a single explanation cannot apply to them all (Goudie 1990; Gregory 1976; Williams 1980). While the debate about dry valley formation remains unresolved, a composite explanation is emerging that, while many originated and evolved through both fluvial erosion and spring sapping, they were greatly influenced by periglacial activity.

v) A geomorphological model of landscape change

Jones (1999a) suggested that, in view of the division of the Chalklands into a number of slightly differing tectonic/structural units, the search for uniformity of evolution must be abandoned. Over deep geological timescales this may be true, but over the relatively short timescale of the Quaternary it is reasonable to assume at least broad uniformity. Reconstruction of past landscapes and geomorphological processes based on what remains may be unsatisfactory (Boardman 1992; Douglas 1976) but many hillslopes in mid-latitude lowlands are essentially relict periglacial landforms and have experienced only limited modification under temperate interglacial conditions (Ballantyne and Harris 1994). I have, therefore, constructed a model of landscape change based on the geomorphological processes affecting the Chalk downlands of southern Britain and northern France. This is based on the following explicit assumptions, justified in the preceding sections of this chapter:

- *Since MIS12, the Chalk interfluves have undergone only limited erosion, modified primarily by dissection and gentle surface lowering as a result of dissolution of the subsurface. Limited amounts have been lost through solifluction. Consequently, the general topography of the Chalk downland today differs in degree, rather than in kind, from that of the late Middle to Late Pleistocene;*
- *The southward diversion of the Thames between MIS12 and MIS6 notwithstanding, pre-existing drainage lines were largely maintained*

in southeast England, although deepened and modified under later periglacial conditions;

- *Incision of river valleys occurred broadly in synchrony with 100,000 year Milankovitch cycles, with a median incision rate of 10m per cycle;*
- *Although deepened by later periglacial processes, the pattern of dry valleys has existed since at least the Middle Pleistocene;*
- *Sea-level changes also occurred synchronously with 100,000 year climatic cycles but, with the exception of the breaching of the Weald-Artois anticline, their effects were limited.*

In this chapter I have demonstrated the major implications for the Lower-Middle Palaeolithic record of the geomorphological processes operating on the Chalk downland during and since the Middle Pleistocene. I have also identified the dangers of failing to take those processes into account when using artefact distribution patterns to interpret early human landscape preference. In this thesis I will show why considering these processes is essential when interpreting the record of past human behaviour and why serious questions must be asked about the validity of interpretations of early human landscape which fail to do so. The extent to which this has been the case was assessed in Chapter Three (Current interpretations of early human landscape use and behaviour).

Chapter Six. The impact of late 19th/early 20th century industrialisation on Lower-Middle Palaeolithic artefact collection opportunities.

i) Introduction

In this chapter I investigate the impact on artefact collection opportunities of three processes of rapid industrialisation that occurred during the mid-late 19th and early 20th centuries and consider the implications for the archaeological record.

The three processes were:

- development of the aggregates and brickearth extraction industries;
- construction of the railway network;
- urbanisation and infrastructure development.

In total, 475 (26.8%) of the 1772 entries in my British dataset can be attributed directly to these processes and in France the percentage is 64% (107 sites is out of 167 total). The difference is owing to the different geomorphology and archaeological practices in the two countries, as explained elsewhere in my thesis (*cf.* Chapters Five and Eight) but in both countries the impact on the archaeological record was substantial.

The most significant of the three processes was the development of the aggregates and brickearth extraction industries. In total, 21.3% of the 1772 findspots in my core study areas are attributable to these industries, without which many significant discoveries would not have been made. Indeed, Prestwich's and Evan's 1859 landmark handaxe from St Acheul, buried 12 feet below the 19th century land surface, was exposed by aggregate extraction as were Worthington Smith's primary context sites at Caddington.

The construction of the rail network also had a significant impact on the archaeological record (Kennard 1947) with huge expanses of potentially artefact bearing Pleistocene sediments exposed during the construction of deep railway cuttings (Fig. 6.5). The railways also facilitated the development of large-scale aggregates extraction and enabled it to supply wider markets (Stanier 2000).

The first public, steam-powered passenger and freight line in southern England opened in 1830 and the rail network then evolved piecemeal until 1880, by which date it had all but reached its present extent (White 1982).

Rapid major increases in population following the arrival of a railway, created a demand for houses, roads and public services, resulting in immense urbanisation. The digging of trenches for public services, house foundations and other public buildings all potentially exposed Pleistocene sediments and created opportunities for artefact collection and more. Worthington Smith (1894, 203) found the best sections of his Palaeolithic floor at Stoke Newington during the digging of house foundations and graves in Abney Park cemetery.

Throughout my thesis I use three separate terms for my data entries – 'Findspots'; 'Dataset entries' and 'Total dataset entries'.

As I explained in Chapter Four, multiple findspots with individual HER, PAS or SERPP/TERPP numbers but which share the same NGR generate only a single marker on ArcGIS generated maps. I therefore use the term 'Findspots' only when counting the number of sites actually marked on my maps. Such 'findspots' include both single entries in my site lists and multiple entries which have an individual HER, PAS or SRPP/TERPP number but share a single NGR and so are mapped as one in ArcGIS. An example of the latter is the Long Valley gravel pit at Croxley Wood, South Chilterns, which has separate entries in my site lists for five finds made at the same NGR (TQ 75 948) but which generates only a single marker on the maps. Any column headings in tables or textual references to numbers of 'findspots' always relate to the geological mapping.

'Dataset entries' is the term I use for both of the above categories of data when counting the number of entries in my site lists without reference back to the geological mapping. In this case, Long Valley Gravel Pit has five 'data set entries'. Both the terms 'Findspots' and 'Dataset entries' relate only to finds situated on the Chalk bedrock footprint of each interfluve, calculated in $100km^2$ – i.e. if a table has a column in which densities are given per $100km^2$ then it deals only with 'Dataset entries'. These include findspots on all superficial deposits but exclude those occurring on other bedrocks.

'Total dataset entries' includes all 1772 entries in my English Chalk uplands Lower-Middle Palaeolithic dataset, regardless of the bedrock on which they sit. In the tables which follow, figures quoted in tables 6.1 and 6.2 are the number of 'total dataset entries' attributed to gravel/brickearth extraction and urbanisation. In table 6.3 the finds density per 100km^2 includes the total of all 'dataset entries' attributable to each of the gravel and brickearth pits mapped onto the Chalk footprint of an interfluve – e.g. all five of the Long Valley Gravel Pit 'dataset entries' are included in the calculation, although only 3 gravel pits are mapped onto the Tring to Wendover interfluve.

By the end of this chapter I expect to have answered the question of whether/how artefact density in a unit of landscape relates to increased 19th and early 20th century industrialisation on that unit.

ii) Aggregates extraction

Palaeolithic archaeology and the aggregates extraction industry are both interested in surviving Pleistocene deposits, albeit for very different reasons. Except for the commercial extraction of clay, sand and gravels, most deeply buried Palaeolithic sites would have remained buried and unknown, while from 2002 to 2011 the British Government's *Aggregates Levy Sustainability Fund* (ALSF) underwrote Lower-Middle Palaeolithic and Pleistocene research in England to the tune of £8.8 million (White 2016a). The ALSF also funded regional frameworks and mineral assessment plans critical to understanding, managing and, where possible, conserving what is left of the Pleistocene landscape. On the other hand, large-scale mechanised extraction of aggregates is a rapidly destructive process with the potential for lithic scatters, finds horizons and whole sites to be swept away in minutes.

The British Geological Survey's BRITPITS database (www.bgs.ac.uk/products/minerals/BRITPITS.html) includes 193,470 entries relating to inactive and former mines and quarries (Cameron *et al.* 2014) giving some idea of the scale of mineral extraction in the past. Unfortunately, however, judging from the sample data downloadable (there is a significant fee for accessing the full dataset) it does not include information on operational dates, limiting its usefulness for my research.

The most profitable period for Palaeolithic archaeology was essentially between 1859 and 1920, the era when quarries and brick pits were dug by hand. During that time most British known and celebrated Lower-Middle Palaeolithic sites were discovered (Pettitt and White 2012; Roe 1981; Wymer 1968; 1999) with finds numbering hundreds of thousands.

Before the mid-19th century, small pits were opened as required for the extraction of chalk, brickearth and gravel (Stanier 2000). Most, if not all, chalk, clay and gravel pits were hand-dug and hand-sorted until 1920 at the earliest and manual methods of gravel digging and sorting persisted into the 1930s. However, increased demand in the late 19th and early 20th centuries led to fewer, larger extraction sites, often in areas where depths of deposits were thicker and more extensive (Catt *et al.* 2010) as well as to the rise of large quarrying operations under the influence of industrial entrepreneurs and the creation of limited liability companies to work them. Limestone and Chalk began to be quarried on an industrial scale for making lime and cement, most notably in the Lower Thames valley, for example at Northfleet, increasingly using mechanised processes (Stanier 2000; Wessex Archaeology1993a, 75; Wymer 1999, 69). The appearance of the mechanised processing plants was probably gradual, adopted first at the larger-scale operations while smaller pits continued to be hand-worked (Hosfield 1999 50, 17) but by the 1950s fully mechanised gravel workings were commonplace.

The traditional brickmaking industry consisted of a large number of relatively small works dispersed throughout the country, with concentrations around urban areas. Once the brickearth was extracted to a certain level or building activity slumped, many operations closed down and the land returned to cultivation. Expansion of the industry, when necessary, was accomplished by an increase in the number of small works rather than a fundamental change in the size of individual firms (Watt 1990). Fig. 6.1 shows the numerous brickworks concentrated around Chesham on the Tring to Wendover interfluve of the Chilterns in the century between 1850 and 1960. The dense concentration of works on the plateau top in the Bellingdon/Cholesbury/Asheridge area (*cf.* fig. 6.1) is particularly notable.

Gravel pits are not pinpoint items on the map but can sometimes stretch for more than a kilometre and even when finds can be tied to a particular pit

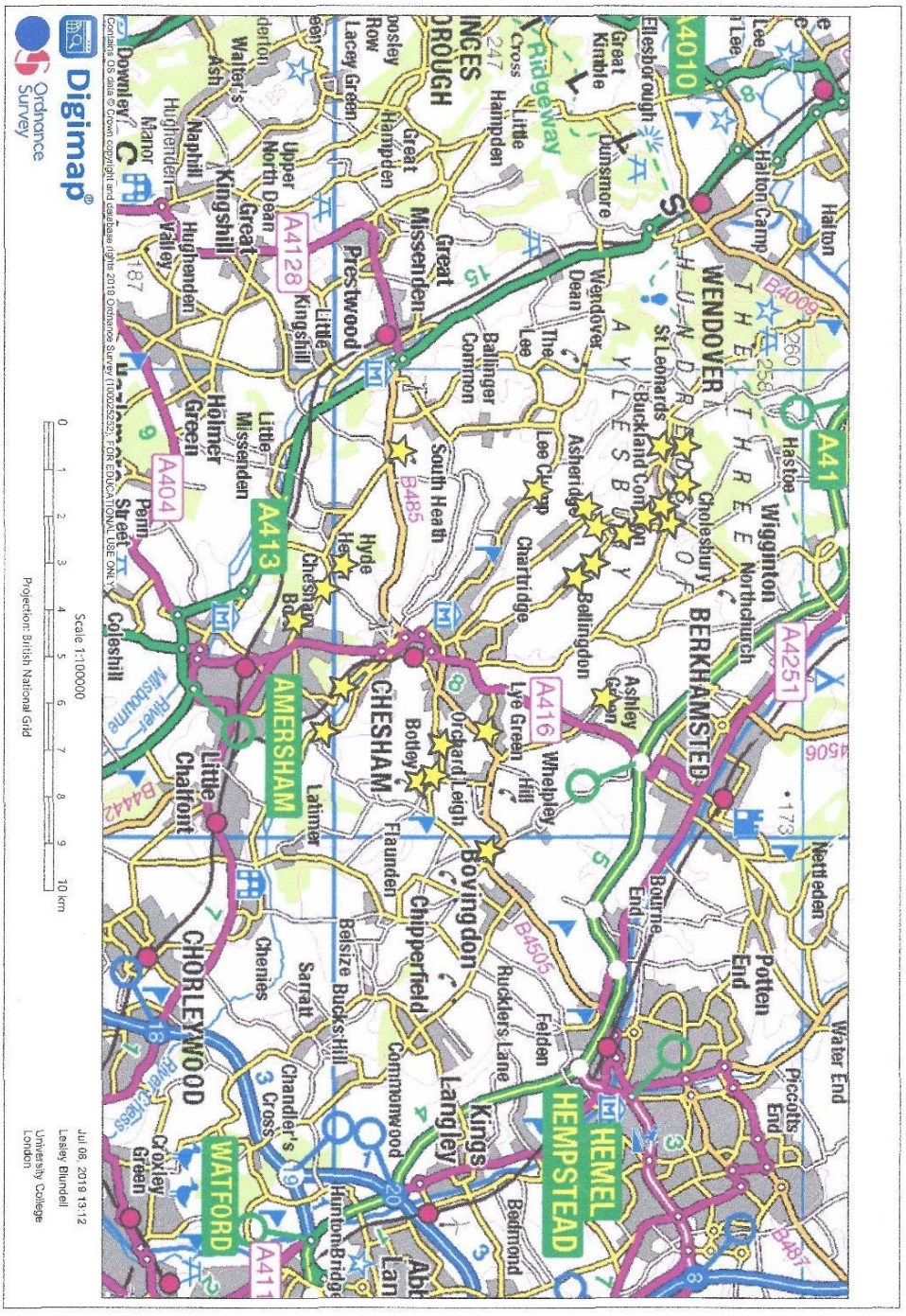
their provenance can, at best, be ‘estimated’ or ‘general’ (Hardaker 2007). Many pits were known by the names of their owners (e.g. Powdrill’s Pit, Kensworth Common; Knight’s Pit, Farnham), some of whom operated different pits at the same or different times. Similarly, gravel companies operated several pits, as did some local authorities (Wessex Archaeology 1993a, 44).

As described in Chapter Seven, working practices in hand-dug gravel pits meant artefacts were usually only noticed during the sorting process, not during digging (Cranshaw 1983; Dale 1912; Treacher *et al.* 1948). The impact of mechanised sorting on the opportunities for noticing artefacts was, therefore, enormous. For example, although numerous palaeoliths had been found previously in the Wallingford Fan Gravels, none were found after the introduction of mechanical excavators (Arkell 1943-4).

As early as 1912 Salomon experienced the deleterious effect of mechanised excavation on collecting opportunities at the site of Les Ruyots (Hermies le Tio Marché), In less than three hours, 600m^2 of the canal basin had been excavated by a digger and more than 10,000 artefacts, flakes and cores loaded onto wagons. By redoubling his activity, Salomon was able to recover several interesting artefacts from the digger bucket and to examine at least 3000 pieces which had been broken or retouched by the extraction process (Salomon 1912a).

Data from nine sites in Hampshire also suggest a broad quantitative difference between artefact collection opportunities at sites with manual and mechanical sorting processes, with a general downshift through time. At Kimbridge Farm (where sorting was mechanical) and Bleak Down Pits (where both manual and mechanised sorting took place) the average number of bifaces year^{-1} was 4 and 11 respectively. At Dunbridge (Fig. 7.10) Great Pan Farm and Wansunt pits, with manual sorting only, the average numbers per year were 40, 35 and 120 respectively. By the 1990s a watching brief at Dunbridge yielded just four bifaces year^{-1} (Hosfield 1998, 101;1999, 49).

Fig. 6.1 Brickworks around Chesham, Buckinghamshire 1850 – 1950.
Each yellow star represents a brickworks



© Crown copyright and database rights 2019 Ordnance Survey (100025252)

Fig. 6.2 Hand-digging at H.G. Matthews Bellingdon brickworks in the 1920s.

© H.G. Matthews Ltd.

Collecting opportunities thus changed significantly during the early years of the 20th century. In the Middle Thames Valley for example, within Reading and Caversham, the context of exposed gravels broadly shifted after World War I, from large gravel pits such as Toots Farm Pit and Grovelands Pit, which had yielded so many palaeoliths for Treacher and George Brown, to smaller urban infrastructure projects, such as the laying down of the main Caversham drainage in 1932-33, in Highmoor Road and Harrowgate Road (Hosfield 2009; Wymer 1968).

In the Somme Valley collecting opportunities also diminished during that period. In the early 19th century there were ~70 active quarries, of which only ~20 survived by 1951, several of them mechanically excavated and therefore without any possibility of study or collecting (Breuil 1951).

North Downs

In Kent aggregates extraction and associated industries (brick and lime works) have been significant both to the local economy and land uptake,

the River Terrace flint gravels of the Darent, Medway and Stour being particularly important.

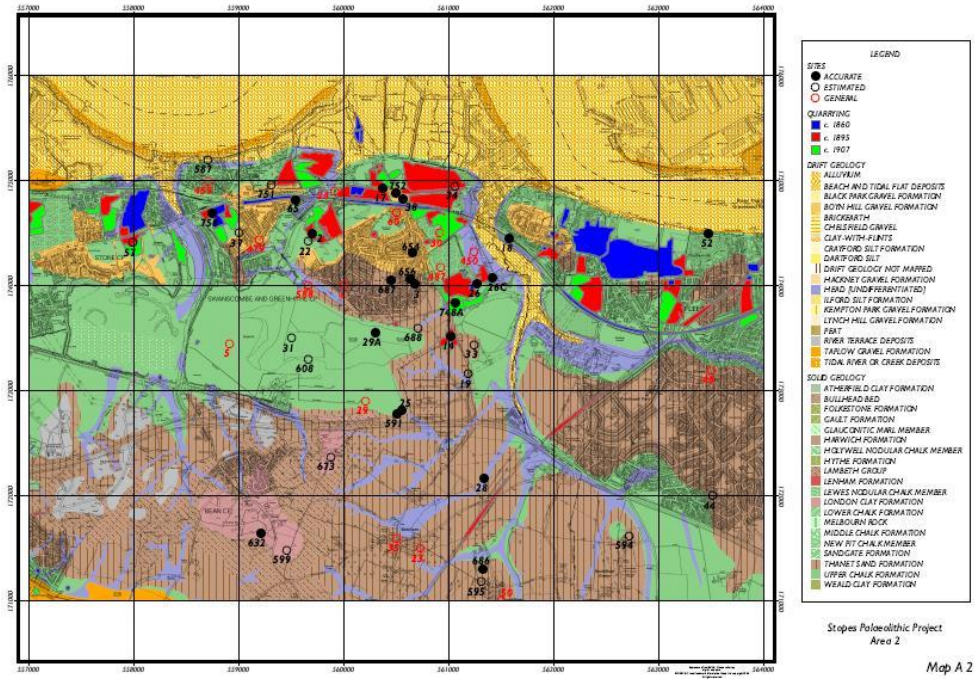
The Lower Thames Valley, between Crayford and Northfleet is the richest and best-known area of Britain from the point of view of Palaeolithic archaeology (Wymer 1999, 67), thanks largely to the expansion of the local cement industry in the late 19th century to meet the demand for chalk and clay. Cement production was concentrated on Northfleet (White 1987) where there was little overburden on the Chalk and flood plain alluvium provided the clay that was also essential for cement-making. The riverside location offered the cement industry transport for its products but as all the available Chalk near the river was quarried away it became necessary to go further inland, where substantial Middle Pleistocene deposits had to be removed to reach the Chalk bedrock. As a result, large expanses of these archaeologically rich sediments were exposed in the vast quarries that appeared by the 1880s on both sides of the river, at Greenhithe, Stone, Swanscombe, Northfleet, Grays and Thurrock (Wessex Archaeology1993a, 75; Wymer 1999). All are now defunct.

As early as 1834 a cement works was established at Northfleet by William Aspdin, the founder of Portland Cement. The number of quarries grew rapidly and in 1900 24 small cement companies, mostly on the Thames and Medway estuaries, joined together to form the Associated Portland Cement Manufacturers Ltd (APCM, later Blue Circle Industries, now Lafarge). In 1911 a further 35 companies joined the consortium. The APCM actively supported the work of the British Museum in investigating the archaeological finds from the gravel deposits overlying the chalk in some of their pits (Abbot 1911; Roberts 2013; Scott 2010).

For a number of years from 1909 onwards George W. Butchard, the APCM's Northfleet area manager, corresponded regularly with the Museum's Reginald Smith and the company actively encouraged and paid their workers to retain Palaeolithic material. Butchard's jurisdiction included the key sites of Baker's Hole and Barnfield Pit (Scott 2010) and by 1911 the APCM workers had amassed "an immense collection" (Abbott 1911, 467) of artefacts. In 1912, Smith and Dewey began their excavations within the company's quarry at Swanscombe (O'Connor 2007). The directors of the APCM and their manager were similarly supportive in facilitating the

excavation of the primary context Palaeolithic flint-working floor discovered in a solution hollow in the Chalk in their extensive quarry at Frindsbury, Rochester (Cook and Killick 1924).

Fig. 6.3 Position and date of quarries in the Swanscombe area.



Sites shown mark locations of Henry Stopes' findspots. (Reproduced from Wenban-Smith 2004a Map A.2).

The brick-making clay required for Victorian urban expansion was also plentiful on the Lower Thames, between Crayford and Erith. Small pits already existed but now they too were extended until virtually the whole deposit of Crayford Brickearths had been removed. The brickmaking industry in the Crayford area declined after World War One because of dwindling reserves of Brickearth and competition from machine-made bricks from elsewhere (Wessex Archaeology 1993a, 79).

In the early 20th century, gravel and brickearth began to be dug on a large scale on the river Stour at Canterbury, Sturry and Fordwich. The high-level pre-Anglian terrace deposits at Fordwich and Canterbury contain evidence of early pre-Anglian occupation dating to 700–500 ka while the middle-level terraces contain exceptional concentrations of artefacts dating to 425-250 ka (Kent County Council 2018). Brickearth deposits have also produced substantial numbers of Palaeolithic finds, particularly at Sturry and Fordwich, with brickearth pits near Canterbury including Gaskins Pit, Vauxhall Brickworks and the large Forty Acre or St. Stephen's pit, at Hackington. The richness of these gravels and brickearths was compared

by Dewey and Smith (Dewey1925; Dewey and Smith 1925) with those of the Swanscombe and Dartford areas. The Sturry and Fordwich gravel pits ceased working in the 1950s and gravel extraction now takes place mainly on the floodplain of the Great Stour, while large-scale digging of clay for brickmaking has ceased (Wessex Archaeology 1993a).

There is a long tradition of clay and chalk mineral extraction in Surrey, as well as associated industries such as lime, cement and brickworks (Wessex Archaeology 1993a). Considerable aggregates extraction has taken place in the valleys of the Thames, Lodden, Blackwater and Wey but, except for the rich pits at Farnham which account for 35 of the 40 Surrey finds in my site lists attributed to gravel pits, very small numbers of palaeoliths have been found in the river gravels of these drainage areas. Virtually nothing has been found in the river gravels along the Wey and Mole between the Chalk escarpment and the Thames, where there has been little commercial exploitation of the deposits (Wessex Archaeology 1993a, 70).

South Downs

The relatively small number of Lower-Middle Palaeolithic finds in East and West Sussex is thanks largely to there being little commercial exploitation of the Sussex river gravels at the end of the 19th century when the bulk of British Palaeolithic material was collected (Woodcock 1981). The majority of the Sussex river gravels are too thin and loamy to be a source of aggregates and West Sussex gravel is generally dirty, with a low cost-effectiveness and requires a high land uptake (Wessex Archaeology 1990, 26; 1993b, 57). Limited gravel extraction took place in the past in the East Sussex valleys of the Ouse, Cuckmere and Rother although this had largely ceased by the 1950s. Gravel was worked in a number of pits, e.g. around Hardham and Glebe Farm and there were some shallow pits between the rivers Chilt and Stor while brick clay, Gault and Chalk were exploited around Pulborough and Storrington (Wessex Archaeology 1993b, 43). There are perhaps more Chalk pits around Lewes than anywhere else in the Anglo-Paris Basin (Mortimore 1997).

For several years, R. Garraway-Rice maintained a watching brief on terrace gravel extraction pits on the river Arun and its tributary the Western Rother, an area ~16kms by ~5kms (ten miles by three miles). Within that area he observed 11 pits and sections showing river-drift gravel, but with scant

results. Workings were small and casual – e.g. by 1905 just a few loads of gravel were dug each winter at Coates Common pit for the use of the Coates Estate, while in 1904 the Thakeham Rural District Council surveyor opened a pit at Wiggonholt especially for road repair at Parham (Garraway-Rice 1905). Only4, or perhaps 5 of Garraway Rice's 11 pits produced palaeoliths and by 1905 all were closed (Garraway-Rice 1905).

The dearth of finds from the Sussex river gravels changes dramatically in the adjoining part of southern Hampshire, especially in the gravels of the Itchen and Test around Southampton. This is due, almost certainly, to the very different gravel and brickearth extraction histories of the two areas and the proximity of the latter to the very large towns of Portsmouth and Southampton. In Hampshire, large stretches of gravels and brickearth have been consistently quarried for many years, the vast majority of the finds being made during the days of manual extraction and reported before the 1930s (Shackley 1981; Wilkinson 2007). The concentration of Palaeolithic findspots in the gravels around the Romsey area can be explained in terms of proximity of the river terraces to the Chalk ridge, those with the highest concentration of artefacts in the Avon and Test valleys (Wood Green and Dunbridge respectively) being located immediately south of the Chalk-Tertiary boundary (Hosfield 1999; Wilkinson 2007).

In the Bournemouth area, where the collection of Palaeolithic artefacts peaked during the 1920s and 1930s, there was an increase from before 1872 to ~1900 in the number and average size of quarries and in the size of the largest quarries, although small quarries (<1000m^2) remained active throughout the period. From 1910 to 1940 the number of quarries decreased but the trend towards larger individual extraction sites continued (Ashton and Hosfield 2010).

Chilterns

The six-inch Ordnance Survey County Series maps for Bedfordshire, Hertfordshire and Buckinghamshire for the opening years of the 20th century show numerous extraction pits for chalk, clay and gravel, most now built over. Around Luton, Whipsnade, Kensworth and Caddington there were multiple gravel and Chalk pits, with brickworks at Mixies Hill, Caddington, Kensworth Gorse, Slip End and Luton Hoo. These names read like a catalogue of Worthington Smith's findspots, including his primary

context sites at Round Green Luton and at Caddington. Evidence suggests (Sampson 1978) that the Caddington brick pits were reducing production during the opening years of the 20th century.

The Cottages pit was owned by G. Bunn, brick merchant of Luton and the Gatehouse Field pits by E. White, brick- and tile-maker of Dunstable. Tipple Hill Farm and Buncers Farm brickyards were owned by a Mr. Gilliam and the others were run by J. Saunders, brickmaker. Between 1898 and 1903 *Kelly's Directory of Bedfordshire and Huntingdonshire* dropped its entries for Bunn and Saunders and, with two or more of the main Caddington brickyards closed down, claypit digging was less active (Sampson 1978). The artefact supply dwindled after 1905 (Sampson 1978 Fig. 1-3) and in 1906, Smith was complaining that he had found very little at Caddington that year. It was during this period that he began work at Round Green and adjacent sites several miles further from Dunstable.

Hertfordshire also had numerous gravel pits, primarily in the glacio-fluvial deposits of the Hitchin Gap. Many were archaeologically productive, including Jeeves Pit and Ransoms Pit, Hitchin and the particularly rich examples of Mill End Gravel Pit, Rickmansworth and Croxley Green Long Valley Woods Pit (Wessex Archaeology 1996).

Chalk is still extracted from the Chilterns on a large scale (Fig. 6.4) but today the major minerals extracted in Bedfordshire and Hertfordshire are aggregate sand and gravel from the river valleys. In Oxfordshire and Buckinghamshire the Terrace gravels of the Middle Thames Valley were being exploited at archaeologically prolific gravel quarries such as Deverill's and Cooper's Pits at Burnham Beeches and Dean's Pit Great Marlow. Similarly rich brickearth pits such as Dorney Wood, Burnham and Dean's Pit, Marlow were also heavily exploited.

In all, 378 of my 1,772 British total findspots can be attributed to gravel or brickearth extractions processes, including surface finds from the immediate area around a pit. For the Somme the number is 43 out of 167 (Table 6.1).

Fig. 6.4. Kensworth chalk pit, near Dunstable Bedfordshire. The town of Dunstable can be seen in the background.

(© Google GB GeoBasis-DE/BKG (2009).

Table 6.1 Chalklands Lower-Middle Palaeolithic total dataset entries attributed to gravel/brickearth extraction. Figures in parentheses indicate number of additional, surface finds from the immediate area.

Study area	Gravel extraction	Brickearth extraction	Total dataset entries	% of 1772 total dataset entries
Kent North Downs	44 (3)	17	64	3.6
Surrey North Downs	40[1] (1)	2	43	2.4
North Chilterns	27 (14)	20	61	3.4
South Chilterns	102 (8)	10	120	6.8
Sussex South Downs	12 (6)	1	19	1.1
Hampshire South Downs	58 (9)	4	71	4.0
Totals	**324**	**54**	**378**	**21.3%**
Somme Valley	32	11	**43**	**25.7%** of 167 sites

1.*Includes 35 from the gravel pits around Farnham*.

iii) Construction of the railway network

During the late 1830s and early 1840s there was a boom in railway promotion, known as the Railway Mania. This culminated in the 1845-46

Session of Parliament when 815 railway bills were deposited, 280 of which received the Royal Assent, authorising the building of 7161.6 kms (4,450 miles) of route by numerous rival companies across Britain as a whole (White 1982). In 1846 a Commission on London Traffic was set up to consider the nineteen of these bills affecting central London alone (White 1987).

The chalk ridges of the outer rim of the London Basin, formed by the Chilterns and North Downs, controlled the alignment of trunk railway lines in and out of London, the dipslope dry valleys which lead back to gaps in the escarpments enabling main-line railways radiating from London to cross these barriers (White 1987). For example, the line from Paddington to Swindon follows the Thames through the Goring Gap beyond Reading; the West Coast Main Line from Euston climbs the Gade and Bulbourne valleys to the Tring Gap and the Brighton line uses the dry valleys south of Croydon to reach the Merstham Gap. Deep cuttings were required through the gaps (White 1987), revealing Pleistocene deposits and providing opportunities for artefact collectors. Table 6.3 shows the number of findspots on each interfluve attributable to railway construction.

In total,18 (1.1%) of the total dataset entries in my core study areas can be attributed to work on railway construction and maintenance. Fourteen of these lie within the footprint of an interfluve, including six in the Chilterns and eight in Kent (four of which were discovered during the late 20th century building of the Channel Tunnel rail link).

North and South Downs

In the late 1830s three trunk lines were promoted almost simultaneously, each connecting London with an important point on the Channel coast, at Dover, Brighton and Southampton. Construction of the first of these was begun to Dover by the South Eastern Railway Company in 1837, with trains finally reaching there in 1844. The East Kent Railway (later the London, Chatham and Dover) completed its rival line to Dover in 1861. A number of branch lines developed from each main line, in many cases serving the same towns because the main lines were built by rival companies (White 1987, 25). Most notable of these were the feuding South Eastern and London and the Chatham and Dover companies. Similar squabbling between competing railway companies existed over services in

East Sussex and Hampshire (White 1982) and is well illustrated on the Isle of Wight, where the entire system of only 72.82 kms (45.25 miles) was owned and worked by five rival companies.

The first group of branch lines sprang off the Chatham's main line and the North Kent line between Gravesend and Rochester. The second group left the main South-eastern line in the Maidstone, Strood and Elham Valley areas while the third group ran across Romney Marsh. There were also several genuinely independent railway lines with their own stock and management, including the Kent and East Sussex Light Railway, the East Kent Light Railway, the Romney Hythe and Dymchurch Light Railway and the Rye and Camber.

The London and Brighton Railway was incorporated in 1837 to build a line to Brighton, then the largest town outside London, with branches from there to Shoreham and to Newhaven via Lewes. The ceremonial and public opening of the route in September 1841 ushered in a new economic and social era for the whole of Sussex and for Brighton in particular (White 1982). Between 1841 and 1871 the town's population grew from 46,000 to 99,000 (White 1982, 82). In 1849 the railway reached Eastbourne, causing a similar population explosion.

The London and South Western Railway Company established a virtual monopoly over most of Hampshire and parts of neighbouring counties, including Surrey. It was an area of special importance as it included Portsmouth, Southampton and Bournemouth, one of the largest seaside resorts. By 1911, the Company had 1544.6kms (966 miles) of rail open to traffic (White 1982).

Chilterns

The Great Western Railway was incorporated in August 1835 to connect London to Bristol, following the Thames valley through the Goring Gap. The line reached Maidenhead in 1838, Reading in 1840 and Bristol in 1841 with branches to Oxford, opened in 1844, Gloucester and South Wales (Christiansen 1981). In 1849 rival branches opened to Windsor and Eton from Slough and a branch to Marlow in 1873. A railway station opened at Twyford in 1839. Access to both the local and national railway networks opened up artefact collecting opportunities over a wide area, enabling collectors such as Llewellyn Treacher to lead Geological Society

excursions to gravel pits at nearby places like Shiplake, Oxfordshire in 1926 (Treacher 1926) or further afield, for example to Limpsfield via Paddington in 1908 (Treacher 1909).

London to Birmingham railway services started in September 1838. In 1848 the construction of a branch line from Leighton Buzzard to Dunstable connected the latter with the London to Birmingham main line and Dunstable (later Dunstable North) station was opened. A second station, Dunstable Town, opened in May 1858, linking the town to Luton on the opening of an extension of the Welwyn and Hertford railway.

The track to Welwyn was completed in September 1860, connecting Dunstable to the Great Northern Railway's (GNR) mainline from London to Doncaster. As a result, Dunstable was linked by train not only to Luton and Welwyn but also to Harpenden and, Wheathampstead. All are places in which Worthington Smith found palaeoliths in gravel pits and which, without the railways, he could have reached only with great difficulty. For example, in 1886 Smith found two *in situ* artefacts and a scraper in one of the large gravel pits on Nomansland Common, Wheathampstead. Dunstable's link to the main lines running into London, also gave Smith access to that city and to points further south. In 1857 the Midland main line reached Hitchin, already on the GNR line from Doncaster to London and began running passenger trains into Kings Cross, using the Hitchin Gap to cross the Chiltern escarpment.

The railways had first reached Luton in 1858 when the Luton, Dunstable and Welwyn Junction Railway, an extension of the Welwyn and Hertford Railway, opened Luton Bute Street station. In 1860 New Mill End station (later Luton Hoo station) was opened by the Hertford, Luton and Dunstable railway on its branch line between Hatfield and Dunstable. Both were taken over by GNR in 1861. In 1868, Midland Railway opened Luton Midland Road (now Luton) station on its extension to St Pancras and by 1901 the population of Luton had nearly trebled, to 36,400 people (www.populstat.info).

In 1897, joint powers were obtained by the Great Western and Great Central companies for a line from London through the Chilterns to High Wycombe and beyond. The Watford and Rickmansworth Railway's line from Watford to Rickmansworth opened in 1862, followed by a second line,

run by the Harrow and Rickmansworth company, which reached Rickmansworth in 1887, Chesham in 1889 and thence to Amersham and through the Wendover Gap to reach Aylesbury in September 1892. In this way the artefact rich gravel pits in the Rickmansworth area became more readily accessible to collectors.

Fig. 6.5. Dunstable Town Station in the 1900s.

Public domain postcard.

Greater London

London's first railway, the London and Greenwich, opened in 1836, with its terminus at London Bridge. Eventually, there were four railway companies running trains south of the Thames, each seeking a City and a West End terminus. The London and Croydon opened in 1839, with powers for a terminus on the north side of the river. In 1862 the London, Brighton and South Coast obtained powers for a line from London Bridge to Victoria. The station served inland towns and middle-class suburbs stretching continuously from Dulwich and Streatham to the North Downs, as well as the Sussex and Thanet resorts. In 1859 the Charing Cross Railway was incorporated, the new terminus opening in 1864.

In 1846, the railway line from Clapham Junction reached Richmond, being subsequently extended first to Windsor in 1847 and then, in 1848, to the newly opened Waterloo terminus. In 1898 the 'Drain', a two-mile tube from

Waterloo to Bank (of England) station opened as an extension of Waterloo's suburban system, linking the terminus to the City.

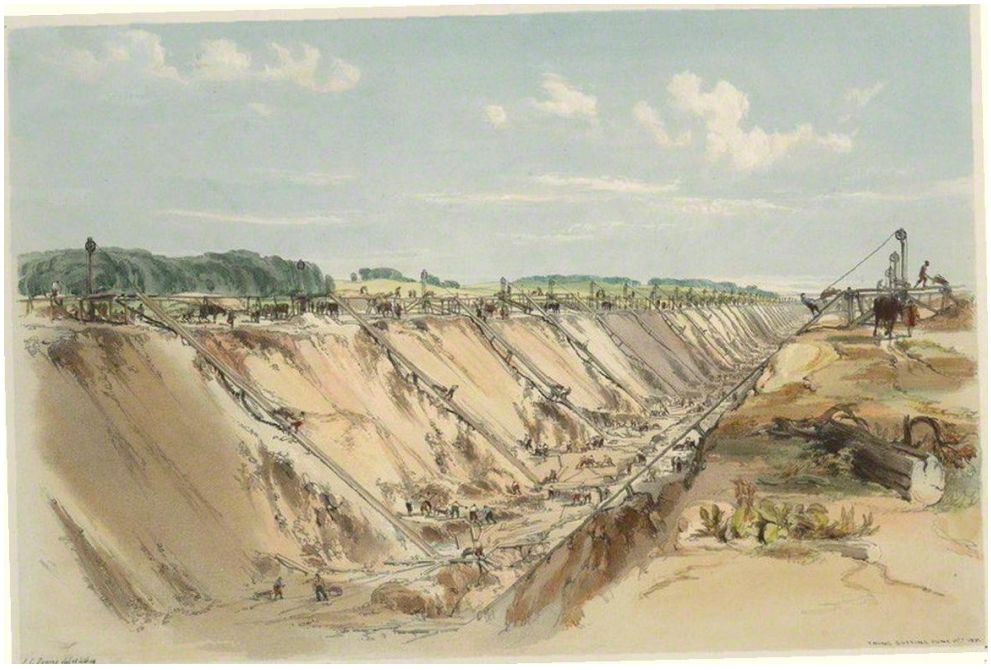
South Eastern Railway's north Kent lines developed an extensive local traffic between London and the Thames-side towns. In 1849, a line opened to Lewisham, Woolwich, Dartford and Gravesend and in 1864 the Mid Kent railway was extended from Lewisham to Croydon via Beckenham. In 1866 the South Eastern opened the Dartford Loop, a link between the proposed Tonbridge mainline at Hither Green and the North Kent at Dartford Junction. Bexleyheath, now part of the London Borough of Bexley, was linked to the rail network in 1895. In this way, antiquarian collectors in and around London were able easily to access the Chalk and brickearth quarries on the banks of the Lower Thames, including sites such as Bakers Hole and Barnfield Pit. In 1897, for example, F.C.J. Spurrell (1898) led an excursion to Erith by train from the South Eastern Mainline's Cannon Street station. In 1907 and 1911, Chandler and Leach led Geological Society excursions to Crayford and Dartford Heath (Chandler and Leach 1907; 1911) using Crayford, Dartford and Bexley stations.

The scale of railway building operations was enormous. When the first sod of the London and Brighton Railway was cut north of Merstham Tunnel in July 1838, it involved >3,500 men and 57 horses. By 1840 this had grown to 6,206 men and 960 horses, now aided by 5 locomotives. In some small villages along the route, the resident population was boosted by as much as 50% by navvies working on the railway and their families (White 1982). Similarly, the 1.83 mile (2.95 km) long Box Tunnel between Bath and Chippenham on the Great Western Railway's London to Bristol line was constructed by 4000 navies working day and night. The GWR paid for a south aisle to be built for their use at Box parish church (Christiansen 1981). There should have been multitudinous opportunities for spotting Lower-Middle Palaeolithic artefacts during manual excavation on this scale, but this is not reflected in the number of finds recorded in my dataset.

The mechanisation of rail infrastructure construction took place between 1890 and 1919, with increased prominence of steam diggers during that period (Hosfield 1999, 53). Their role was probably only partial before 1920, although perhaps of considerable significance alongside railway navvies in some projects by the turn of the century. There were, thus, two temporally

distinct elements – first the introduction of the steam diggers and second the phasing out of the navvies (Hosfield 1998). As the steam diggers both excavated the cuttings and loaded the material straight into waiting rail trucks their introduction drastically reduced the opportunities for artefact collection, mirroring the impact of the mechanisation of aggregates extraction processes.

Fig. 6.6. Tring cutting 1839. Watercolour by J. Cooke Burne.



© National Portrait Gallery London

iv) Urbanisation

The population of England and Wales more than doubled between 1801 and 1850, with large numbers of workers migrating from rural areas to rapidly growing towns. Victorian urbanisation also required large quantities of suitable brickmaking clay as concentrations of population in these centres created an unprecedented need for new dwellings. Vast increases in demand for bricks after 1850 placed enormous pressure on the brickmaking industry to expand its productivity, the number of small-scale brickworks increasing in response (Watt 1990).

In 1849, when the railways reached Eastbourne, the town's population was only 3,015 (White 1892). By 1851 it had risen to nearly 35,000. The population of Luton almost trebled following the arrival of the railways in 1868, while on the London to Brighton line the towns of Redhill, Haywards Heath and Hassocks were all essentially railway creations (White 1882).

With later Victorian urbanisation the need for sand and gravel increased accordingly (Wessex Archaeology 1993a, 43) and in the Lower Thames valley alone the archaeological and geological resource has suffered sustained pressure from industrial development for over 150 years (Schreve 2016). Gravel was also needed as ballast for railway lines, such as the LNWR connecting Dunstable with Leighton Buzzard (Smith 1894, 91) while the sand and gravel from the pits at St Acheul were destined for road repair and building purposes.

London's development since 1840 has resulted from the growth of trade, commerce and industry, fostered by developments in communications, particularly the railways (White 1987). In 1841 the population of the area now covered by Greater London was just over two million; by 1861 it was more than three million and by 1901 it had risen to about five and a half million. By 1921 the figure was nearly six and a half million. For example, following the coming of the Eastern Railway line to Enfield, North London in 1872, the population of Tottenham, on that line, doubled between then and 1881 and again by 1891 (White 1987).

The impact of the railways on urban development can be seen equally clearly on the towns and villages of the west Sussex coast between Brighton and Havant. When first opened during the 1840s, with the exception of Shoreham, Worthing and Chichester, the railway line served few places of any importance. Growth of these towns and some of the intervening villages was fairly rapid during the 19th century and by 1900 their populations had doubled or trebled (White 1982).

The railways first reached Southampton in 1840, coinciding with the building of new docks and facilitating the town's growth over the next half century. The railway companies gradually took over the cross-Channel docks until by 1911 Southampton had become the principal ocean passenger port in the country (White 1982). In 1841 the population of Southampton was 27,523; in 1851 this had risen to 34,108 and by 1911 it reached 145,096.

The implications for artefact collecting opportunities of such massive urbanisation lay in the numerous excavation projects associated with the process, including the digging of trenches for the installation of public services, road and house building. In Southampton, for example, between

the 1860s and 1920s many palaeoliths were found by workmen digging drains, house foundations and cellars, during the preparation of roads and in the gravel pits supplying the required aggregates (Wessex Archaeology 1993a,106-110).

The transport of gravel from elsewhere for use in urbanisation projects led to archaeological finds including, on occasion, sites of national significance. Worthington Smith's first finds were made in North London in 1878 in gravel brought to the area by rail for road mending. The gravel came from three large pits near Hertford and yielded a large number of good flakes and a few implements (Smith 1894, 184). Many of the most perfect specimens illustrated in "Man the Primeval Savage" were found by Smith in newly gravelled roads or on gravel heaps, where it was common to find recently broken implements such as the specimen Smith found in pieces in a cart-rut in Lower Clapton, where a cart wheel had just passed over it (Fig. 6.7).

In 1888, Smith observed some newly-laid-out gravelled roads by the Dog-Kennel field behind Dunstable grammar schools and, over several days searching, found five Palaeolithic implements and a few ochreous flakes (Smith 1894, 93). Learning from the road-maker that the gravel had come from a number of different places he visited all of them repeatedly and in 1889 found his *in situ* Palaeolithic implement in Pit A at Caddington – see Fig. 7.5 (Smith 1894, 93). This led to his monitoring all seven of Caddington's brick pits, plus others in the vicinity and the identification of one of Britain's 'flagship' Lower-Middle Palaeolithic sites at the Cottages.

The relationship between late 19th/early 20th century infrastructure development and the exposure of Pleistocene deposits was two-fold. First, the demand for aggregates, especially gravel, for road and railway building led to an increase in scale of extraction; second, the physical construction of road and rail routes often resulted in the exposure of Pleistocene deposits in deep sections in cuttings.

There are five interfluves in my core study areas which have no dataset entries attributable to the industrialisation processes discussed in this chapter (see Table 6.3). These include one in the North Chilterns (Dagnall to Tring), one on the Surrey North Downs (Wey to Blackwater Loddon) and three on the South Downs (Eastbourne to Cuckmere, Cuckmere to Ouse, and Meon to Itchen).

Fig. 6.7 Smith's restored road-find from Lower Clapton.

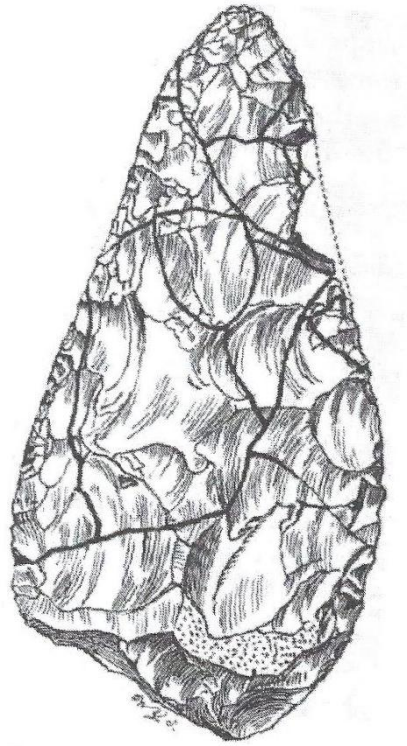


FIG. 153.—Restored implement, Lower Clapton. Half scale.

(Reproduced from Smith 1894 Fig.153).

Table 6.2 Total Chalklands Lower-Middle Palaeolithic dataset entries attributed to urbanisation processes.

Study area	Roads	Canals	Railways	Building works	Utility etc trenches	Totals	% of 1772 dataset entries
Kent North Downs	9	0	9	9	2	29	1.60
Surrey North Downs	0	0	0	2	1	3	0.17
North Chilterns	2	0	4	1	1	8	0.45
South Chilterns	6	0	4	14	14	38	2.10
Sussex South Downs	2	0	1	4	2	9	0.50
Hampshire South Downs	1	0	0	7	2	10	0.60
Totals	**20**	**0**	**18**	**37**	**22**	**97**	**5.50%**
Somme	34	32[1]	2	5	4	**77**	**46.10%** of 167 entries

1. 23 for the Canal du Nord and 9 for the Canal Seine-Nord Europe.

In the Chilterns, the Tring to Dagnall interfluve consists primarily of the 20km^2 of the Ashridge Estate which, from 1283 until the Dissolution, belonged to Ashridge Priory. Passing to the Crown in 1538, in 1604 it became the property of the Egerton family, who held the estate until 1926 when the National Trust acquired the land, which it has continued to manage as a working estate (https://www.nationaltrust.org.uk/ashridge-estate). Part of it became a golf club in 1932, another 640 hectares of the commons and woodland being a designated Biological Site of Special Scientific Interest. As a result, the aggregates extraction that allowed antiquarians to make finds on other Chiltern interfluves did not occur and little of the estate has come under the plough. The interfluve is not crossed by any substantial roads and there has been no significant urbanisation. By 1901, the population of Berkhamstead, the nearest town, was only 6,371, while that of Tring was just 700. There is also a geomorphological factor specific to this interfluve, which could have affected the application of my methodology (*cf.* Map 10.1).

With the exception of the Eastbourne to Cuckmere interfluve (Eastbourne's population was 43,300 in 1901), the nearest town to each of the other interfluves without urbanisation dataset entries was still relatively small, with only Winchester exceeding 20,000. On the South Downs, aggregates extraction in Sussex was limited and in Hampshire aggregates and brickearth extraction was concentrated off the Chalk interfluve, around the large towns of Southampton and Portsmouth. This was also the case for the Wey-Blackwater Loddon, where the thirty-five gravel pits at Farnham are outside the footprint of the Chalk interfluve and the population of Godalming, the nearest town, was only 8,748 in 1901.

Table 6.3 provides comparative industrialisation data for all 24 interfluves in my core study areas.

v) Summary

In this chapter I have reviewed the impact on antiquarian collecting opportunities of the development of the aggregate extraction industry, construction of the railway network and expansion of urban development and infrastructure. Table 6.1 analyses the numbers of archaeological finds made on each interfluve that are recorded as a result of gravel and brickearth extraction and their percentage contribution to the 1,772 total

findspots. Table 6.2 does the same for urbanisation processes, including road building, house building and trenches for the installation of public services. Between them, aggregates extraction and urbanisation account for 25% of the total number of finds, with 21% and 4% respectively.

Gravel and brickearth extraction exposed large sections of Pleistocene deposits, released Lower-Middle Palaeolithic artefacts from their geological contexts and occasionally revealed *in situ* Palaeolithic land-surfaces. By the late 1940s, however, the archaeologically productive higher terrace gravels were becoming exhausted (Roe 1981, 28-29) and few working gravel pits now remain in the implementiferous deposits from which the antiquarian collections were largely amassed. Where such pits do still exist the use of machinery limits the observational opportunities of both archaeologists and workmen. As a result, the discovery rate of major sites during aggregates extraction has slowed to one or two per generation (White 2016a).

Despite the enormous scale of constructing the railway network, only 18 of my 1772 total dataset entries (1.1%) are recorded as being found during the actual process. Large-scale 20th and 21st century railway construction projects such as HS1, HS2 and Crossrail, while presenting major opportunities for archaeological excavation have, with the singular exception of the Ebbsfleet elephant site at Swanscombe, likewise added little to the Lower-Middle Palaeolithic archaeological record. Nevertheless, the railways had a significant indirect impact, thanks to their huge demand for aggregates and the facilitation of travel they offered. For example, several artefacts were found in a gravel pit in Tiepigs Lane, West Wickham, Hayes. The pit was opened in 1881 to provide gravel for the construction of the Mid-Kent Railway to Hayes and its associated roads (Beresford 2018). Once constructed, railway travel allowed collectors and geologists to reach known artefact-bearing deposits outside their immediate home area. During the late 19th and early 20th centuries, London geologists and archaeologists could access a long list of fine sections almost on their doorstep while cheap railway fares enabled frequent visits, including to distant places, for collectors in all areas (Kennard 1947). The railways also facilitated the development of quarries in more remote areas (Stanier 2000) and stimulated the growth of towns. The consequent building and infrastructure works created numerous artefact collecting opportunities through the exposure of Pleistocene surfaces.

Table 6.3 Comparative data and finds density for each Chalk interfluve as measured in 100km^2. *(* Urbanisation column Includes finds from construction trenches, road construction and domestic and commercial building works).*

Interfluve	Interfluve area in 100km^2	Gravel pits	Brickearth pits	Urbanisation findspots*	Railways findspots	Population of largest nearby town in 1901	Total number of dataset entries attributed	Density per 100km^2
South Downs								
Eastbourne - Cuckmere	0.66	0	0	0	0	43,300 (Eastbourne)	0	0.00
Cuckmere - Ouse	0.80	0	0	0	0	11,000 (Lewes)	0	0.00
Ouse - Adur	1.43	2	0	2	0	123,500 (Brighton)	4	2.80
Adur – Arun	0.76	0	0	2	0	22,000 (Worthing)	2	2.63
Arun-Lavant[1]	3.74	7	0	1	0	22,000 (Chichester)	8	2.14
Lavant – Ems	1.21	0	0	1	0	2000 (Emsworth)	1	0.83
Ems – Meon[2]	2.22	1	0	0	0	188,100 (Portsmouth)	1	0.45
Meon – Itchen[3]	1.74	0	0	0	0	20,900 (Winchester)	0	0.00
Itchen – Test[4]	2.20	2	0	0	0	104,800 Southampton	2	0.91

Interfluve	Interfluve area in 100km^2	Gravel pits	Brickearth pits	Urbanisation find spots*	Railways findspots	Population of largest nearby town in 1901	Total number of dataset entries attributed	Density per 100km^2
Chilterns								
Hitchin – Lilley Bottom	1.67	1	4	1	0	10.000 (Hitchin)	7	4.19
Lilley Bottom - Luton	1.74	4	6	1	2	34,600 (Luton)	13	7.47
Luton - Dunstable	1.70	11	4	1	0	16,000 (St Albans)	17	10.00
Dunstable – Dagnall	1.99	4	1	0	0	11,300 (Hemel Hempstead)	11	5.53
Dagnall – Tring	1.23	0	0	0	0	6,371 (Berkhamstead	0	0.00
Tring – Wendover	3.12	3	3	7	1	7,245 (Chesham)	24	7.69
Wendover – Princes Risborough	2.03	1[5]	0	6	0	22,700 (High Wycombe)	7	3.45
Princes Risborough – Goring	5.72	54[6]	2	15	3	72,200 (Reading)	78	13.64

Interfluve	Interfluve area in 100km^2	Gravel pits	Brickearth pits	Urbanisation findspots*	Railways findspots	Population of largest nearby town in 1901	Total number of dataset entries attributed	Density per 100km^2
North Downs								
Folkestone – Great Stour	5.21	2[7]	0	3	0	41,800 (Dover)	5	0.96
Great Stour - Medway	3.82	1[8]	1	3	4	42,500 (Gillingham)	19	2.36
Medway – Darent	2.77	11[9]	2	8	4	27,200 (Gravesend)	30	10.83
Darent - Merstham	1.92	8[10]	7	5	0	133,900 (Croydon)	20	10.42
Merstham - Mole	1.71	0	0	2	0	7,670 (Dorking)	2	1.17
Mole – Wey	0.66	0	0	1	0	15,900 (Guildford)	1	1.52
Wey – Blackwater-Loddon	0.12	0	0	0	0	8,748 (Godalming)	0	0.00

1. There are a further four gravel pits on the Head and raised beach deposits just off the interfluve footprint.
2. There are three other gravel pits on river terrace deposits at Gosport, Fareham.
3. There are three gravel pits just off the Chalk footprint (at Eastleigh, Colden Common and Otterbourne) plus a further nineteen gravel pits around Hamble-le-Rice and towards Southampton.
4. There are a further nineteen gravel and six brick pits around Southampton and Romsey.
5. There are a further six gravel pits and 22 brick pits at Burnham, just off the Chalk, which are between them responsible for twelve entries.
6. There are a further nine gravel pits just off the Chalk at Maidenhead [2], Reading [5], Sonning Charvil [1] and Ruscombe [1].
7. Off the Chalk footprint there are a further four gravel pits on Head and River Terrace deposits at Littlebourne and Bekesbourne plus two brick pits on alluvium and Head deposits at Canterbury.
8. There are three gravel pits just off the Chalk interfluve at Aylesford plus three on Head deposits at Ospringe and Tonge.
9. There is also one brick pit off the Chalk footprint at Bean (Stonewood Brickyard) and one gravel pit off the Chalk at Swanscombe (Eastern Quarry).
10. This does not include the two brick pits and one gravel pit at Limpsfield, which is off the Chalk interfluve. There are a further four gravel pits off the Chalk on Thanet Formation at Dartford.

Urbanisation revealed Pleistocene deposits in house foundations, trenches and even graves, making them accessible to collectors. The growth of centres of population also meant there were potentially more collectors in an area. A plot of collector density across the Hampshire Basin (Hosfield 1998; 1999) suggests that the major urban centres, in which most collectors lived, were subject to the greatest collecting activity. However, the Hampshire Basin was dominated by the very large conurbations of Southampton, Portsmouth (both with populations of >100,000) and Bournemouth with 59,800 people. In areas outside London with no such dominant towns the ‘urban centres’ effect may have been less. In the whole of the Chilterns, for example, there were only 4 towns in 1901 with a population greater than 20,000 (Luton, Watford, High Wycombe and Reading) and only 2 (Luton and Reading) with populations in excess of 30,000.

Nevertheless, as Table 6.3 demonstrates, artefact density in a unit of landscape is clearly related to the collecting opportunities presented by the intensity of late 19th /early 20th century industrialisation in that unit. Where there was significant gravel or brickearth extraction, for example on the Luton to Dunstable interfluve in the Chilterns, finds density is high even when the nearest centre of population was small. It is highest, however, when a large centre of population and significant gravel and brickearth extraction coincided, as on the Darent to Merstham interfluve in the Thames Valley or between Princes Risborough and Goring in the south Chilterns. Conversely, it is lowest when neither factor is present. Given the implications for findspot distribution patterns, the need to take industrialisation processes into account when interpreting the archaeological record is clear.

Chapter Seven. Antiquarian collectors and the archaeological record of the Chalk uplands.

i) Introduction

At least 3,000 places in Britain have produced palaeoliths, from an individual specimen to many thousands from one site (Wymer 1968). The artefact collections amassed between 1860 and 1960 are responsible for the majority of this British Lower-Middle Palaeolithic record, between them accounting for ~78% of the handaxes and 85% of known finds locations (Harris *et al.* 2019). The majority of this archaeological record was amassed in the late 19th/early 20th centuries, during the heyday of gravel-digging by hand.

There is an inherent bias in collected as opposed to excavated assemblages (Harris *et al.* 2019). The scale of the contribution made by the late 19th/early 20th century collectors to the British Lower-Middle Palaeolithic record makes it essential to identify and understand any biases introduced into that record by their collecting activities. That is my purpose in this chapter.

In Victorian times the Chalklands of southern Britain had a significant bias towards the wealthier social classes, who could afford to dabble in archaeology (Allen 1991) and during the late 19th and early 20th centuries extraordinary insights were produced from detailed local knowledge by such collectors (Gamble 2009b). Some of these, such as Worthington George Smith, F.C.J. Spurrell and Victor Commont, discovered highly important primary context sites. Most areas had their own collectors, plus others with a professional interest in archaeology and/or geology, leading to the formation of numerous local and county archaeological societies. These included, in my core study areas, Sussex (1842), Buckinghamshire (1848), Kent (1857), Surrey (1854), Oxfordshire (1839) and Hertfordshire (1845).

Based on the records of the Hampshire antiquarian Ernest Westlake, Hosfield (1998; 1999) concluded that the major factor influencing the distribution of Westlake's findspots was his locally-orientated knowledge of suitable gravels and archaeological exposures, factors which must also have played a significant part in the collecting activities of other antiquarians. Benjamin Harrison and Worthington Smith, for example,

collected regularly, almost invariably on foot, within an approximately six mile radius of their homes.

This was the heyday of gravel digging by hand and the gravels which were being worked were primarily the high and middle terrace gravels of the major river valleys, where so many implements were to be found (Roe 1981). There is, however, very little accurate information about the number of years over which sites were worked or the number of visits made to a site by antiquarians (Hosfield 1998) leaving questions to be answered about their impact on the archaeological record.

As I will demonstrate in Chapter Nine, publicised discoveries promoted intense collecting within a surrounding area, resulting in a 'snowball effect' (Wilkinson 2001, 100) and findspot clusters such as those around Swanscombe on the North Downs dipslope (Ashton *et al.* 2018) Furze Platt on the Chilterns dipslope (White *et al.* 2018) and Dunbridge (Fig. 7.10) in the Test Valley (Hosfield 1998). Major sites in the Middle Thames valley were targeted by multiple collectors thanks to their reputed rich artefact potential, the length of their 'working lives' and the large population in the region (Hosfield 2009).

Antiquarian collectors rarely did their own collecting, instead training trusted workmen on site in return for payment. At Warren Hill, Suffolk, as much as half-a-crown could be obtained for a fine large handaxe, at a time when the weekly wage could be counted in shillings (Hardaker 2012). With well-known sites attracting numerous collectors the demand for saleable artefacts was a bonus for the workmen, pushing up prices and making the trade an attractive proposition for fraudsters (Bell 1898) such as small-time thief Edward Simpson, better known as "Flint Jack" and George Glover, alias "Nobby". As early as 1863, Evans had delivered a lecture on *The forgery of antiquities* to the Royal Institution (Evans 1863) and in 1872, in his *Ancient Stone Implements,* he described methods of identifying such fakes (Lamdin-Wymark 2009). In 1879 Worthington Smith made the mistake of publishing, in the Journal of the Anthropological Institute, the location of every implement-bearing position he knew of in east London, (O'Connor 2007). The resultant rush of curio collectors not only pushed up prices beyond Smith's pocket but led to the forging of numerous fakes by the workmen (Dyer 1978; Smith 1894). Few collectors took the trouble to

check exact provenance and the seeding of archaeological sites through the transfer of genuine artefacts from pits where they were common and therefore cheap to others where they were very rare and so commensurately valuable also gave cause for concern (Roe 1981; Treacher *et al.* 1948).

In this chapter I review the lives and work of the most significant early collectors in my study areas and assess their impact on the Lower-Middle Palaeolithic archaeological record of those areas. They include Worthington George Smith, Llewellyn Treacher and G.W. Smith for the Chilterns, F.C.J.Spurrell, Henry Stopes, Benjamin Harrison and J.A. Montgomerie Bell for the North Downs and Victor Commont, A. Salamon and E. Vignard for the Somme Valley. Table 7.1 summarises their collecting areas and dates, the circumstances in which they collected, their collecting practices, their impact on the archaeological record and the number of findspots attributable to them in my data.

In Chapter Nine I analyse the findspots of Worthington Smith, Benjamin Harrison and Llewellyn Treacher against their geological context and make a detailed assessment of their impact. Maps 9.3, 9.4 and 9.5 illustrate their effect on the archaeological distribution maps. I also analyse the impact of modern fieldwalking and excavation. The interpretations of human behaviour placed on their artefacts by the early collectors was dealt with in Chapter Two.

ii) The North Downs

Benjamin Harrison (1837-1921).

Harrison was "…one of the great 19th century local natural historians …" (Roe 1981, 28), his association with the eolith controversy tending to obscure the fact he collected hundreds of genuine palaeoliths during his career (Harrison 1928; McNab 2009). Harrison lived his whole life in Ightham, Kent, taking over the village general store from his father in 1867 and living there until his death in 1921.

Table 7.1 Antiquarian collectors and their impact

Collector	Collecting dates	Collecting area	Collecting circumstances	Implications of their activities	Collecting practices	Number of identifiable findspots
Benjamin Harrison	1860s-1920	North Downs plateau	Surface finds and occasional excavation	Establishment of pre-glacial man in Britain; at forefront of search for Tertiary Man in Britain; inadvertently set the scene for Piltdown fraud.	Eoliths and handaxes only. Very accurate recording of findspots	35
De Barri Crawshay	1890s	North Downs plateau	Surface finds and occasional excavation	Supporter of Kentish eoliths	Handaxes, flakes and especially eoliths	21 named, only 2 capable of accurate location
F.C.J. Spurrell	1870s-1880s	North Downs Thames dipslope	Brickearth extraction	British Early Middle Palaeolithic *in situ* sites he found at Stoneham's Pit and Bakers Hole still dominate research into the period	Handaxes, flakes, debitage and refitting. Concern with taphonomy, context and manufacturing methods.	11
A.J. Montgomerie Bell	1883-1906	North Downs;	Surface finds on solifluction deposits on North Downs	Supporter of Kentish eoliths	Handaxes + a few flakes. Site name noted + occasionally also height O.D. and date found	14

Collector	Collecting dates	Collecting area	Collecting circumstances	Implications of their activities	Collecting practices	Number of identifiable findspots
Henry Stopes	1885-1902	North Downs – Thames dipslope	Aggregates extraction	Identification and recognition of significance of Greenhithe shell bed	Artefacts marked with identifying site or source number; date of acquisition and occasionally specific stratigraphic context recorded.	15
Garraway Rice	1904-1911	South Downs river gravels	Aggregates extraction	Limited number of finds despite assiduous monitoring reinforces scarcity of surviving archaeology on Downs	Handaxes. Names of pits noted	6 or 7 from Sussex Downs river gravels.
Worthington G. Smith	1885- 1917	Chilterns plateau; Stoke Newington, London	Brickearth extraction Building works/development	Discovered four *in situ* nationally significant Acheulean sites	Handaxes; flakes; debitage. Refitting; environmental evidence. All noteworthy finds labelled with findspot, date found and catalogue number.	33

Collector	Collecting dates	Collecting area	Collecting circumstances	Implications of their activities	Collecting practices	Number of identifiable findspots
Llewellyn Treacher	1888-1943	Chilterns dipslope	Aggregates extraction	Collected from >50 gravel pits, adding enormously to archaeological record but poor documentation and selective collecting otherwise limit his significance	Handaxes only; finds always labelled but often with site pseudonyms, not inventoried, no stratigraphic details recorded	67
G.W. Smith	1890 -1941	Chilterns dipslope	Aggregates extraction	Poor documentation and labelling plus lack of publication limit his significance	Handaxes. Poor documentation. Flakes generally ignored.	14
Victor Commont	1903-1917	Somme dipslopes and plateau	Aggregates extraction + infrastructure construction	Construction of chronostratigraphic sequence for Somme valley; At least 3 primary context sites. Advice to other collectors.	Handaxes, flakes, cores, debitage all collected	At least 15
A. Salomon	1908-1914	Somme plateau	Infrastructure construction	4 primary context sites	Handaxes, flakes, cores, debitage all collected	4
E. Vignard	1909-1911	Somme plateau	Infrastructure construction	At least 3 primary context Mousterian sites		3

Inspired by Lyell's 1838 *Elements of Geology* and introduced to stone tools by the Maidstone shopkeeper Laplain, by 1857 Harrison had acquired a reputation as an antiquary. Constrained by the demands of his business, his collecting activities were confined largely within a few miles around his home and before 1871 took place mostly on Sundays (Harrison 1928).

Harrison found his first palaeolith in 1863 in the gravels of the Schode, a tributary of the River Medway. Already a keen collector of antiquities, including lithics, a visit from Worthington Smith and William Davies of the British Museum in 1878 led Harrison to focus on searching for Palaeolithic implements, concentrating his attention on the Schode gravels until 1885 (Harrison 1928) when he found his first true palaeolith on the plateau at Ash. In 1879 during a first visit to Sir Joseph Prestwich at Shoreham, Prestwich had indicated to Harrison the level at which the valley drifts at St. Acheul occurred. Realizing he had already found implements in even higher-level drifts, Harrison thence forward concentrated on exploring the drifts on the plateau tops (Harrison 1928), primarily on the eastern side of the Darent, which he dubbed "Harrison's Plateau".

Although a geologist, Prestwich had a substantial influence on the antiquarian collectors and, through them on the archaeological record. Not only Harrison's staunch supporter in the eolith controversy, as described in detail in Chapter Two, it was Prestwich who encouraged his collecting on the Chalk plateau. It was also Prestwich who first drew A.M. Bell's attention to the Trail marks in the Limpsfield brickearths and to the Channel deposits at Wolvercote (Bell 1894a; 1894b) the most important Palaeolithic site in the Upper Thames Valley (Wymer 1968).

Harrison recorded the altitudes and geological contexts of his finds, their typology and condition (Wessex Archaeology 1993a) and marked every individual find with its location. He also marked their findspots on copies of the Ordnance Survey 6-inch maps (now in the collections of Maidstone Museum), meaning they are easily relocated. In this best practice he was like Worthington Smith and unlike so many other collectors of his day. The impact of Harrison's collecting activities on the archaeological record is shown in Map 9.5.

Fig. 7.1. Benjamin Harrison, aged 60.

(Reproduced from Harrison 1928. No fig. numbers given).

In 1894 Harrison began to excavate the Plateau gravels at Parsonage Farm, south of South Ash (TQ 595 635) in an attempt to prove that eoliths, so far found only on the surface, could also be found *in situ* in the underlying drift (Harrison 1928; McNabb 2009). Other pits were sunk between 1898 and 1909 at Crowsland, Exedown and Knockmill Wood (Crawshay 1924). In 1921 Harrison's friend, de Barri Crawshay (1924) dug a further pit at South Ash to support Harrison's claim that eoliths and palaeoliths were not found together.

In 1905 Harrison's shop closed, allowing him to spend more time on his collecting activities, which he continued well into his eighties. By 1914,

however, his walks were constrained within a two-mile radius of his home, with occasional motor visits to further places (Harrison 1928). In later years Harrison sold collections of eoliths to interested parties, illustrating and typing the specimens in his 'sale catalogues' (McNabb 2009). In 1899 he was awarded a Civil List pension of £26 p.a. and an annuity of £25 from the Royal Society. In 1926, a memorial fund established after his death purchased the prehistoric site of Coldrum 'Stone Circle' (actually a Neolithic long barrow) near Trottiscliffe, Kent, one of Harrison's favourite places and gifted it to the National Trust in his name (Harrison 1928).

Harrison published little and rarely participated in meetings of learned societies. However, he entered into voluminous correspondence with other collectors and scientists and was, in typical Victorian fashion, a node within a network of similar individuals (McNabb 2012). This exchange network of information and artefacts between different collectors is evidenced by the presence on Davis' (2013) list of Solent antiquarian collectors of people from other areas, such as de Barri Crawshay, Garraway-Rice, Worthington Smith, William Sturge and Hazzledine Warren.

Benjamin Harrison made a crucial contribution to the archaeological record of the Chalk uplands and to the debate about human antiquity in Britain. His worn palaeoliths from the Kent plateau were the first properly contextualised evidence of glacial and pre-glacial man in Britain (McNabb 2009). His eoliths from the North Downs were at the forefront of the debate about Tertiary Man, putting the Chalk plateau at the heart of that debate and setting the stage for the Piltdown fraud of 1912. For those who believed that Tertiary tool-makers had dropped the eoliths of Kent and East Anglia, the discovery at Piltdown of *Eanthropus dawsoni,* their possible toolmaker, was unsurprising.

de Barri Crawshay (1857-1924)

de Barri Crawshay was a man of private means who lived in Sevenoaks, Kent. During the 1890s he collected surface and other finds in the area around his home, as well as material bought from fellow collectors and is known to have paid workmen to collect for him as far away as Southampton (Beresford 2018). Meeting Harrison in 1887, Crawshay became his strong supporter in the eolith debate. Although best remembered for his role from 1890 onwards as the third man of the Kentish Eoliths, during this period

and earlier Crawshay also found palaeolithic material in his search area on the North Downs plateau to the west of the Medway Gap, christened "Crawshay's Plateau" by Harrison. No fewer than 21 Crawshay findspots from that plateau can be named (Crawshay1892; Prestwich 1891; 1892) but, with only two exceptions, these can neither be linked to specific entries in my finds database nor given an NGR. As a result, their impact on the archaeological record could not be mapped separately.

F.C.J. Spurrell (1842-1915)

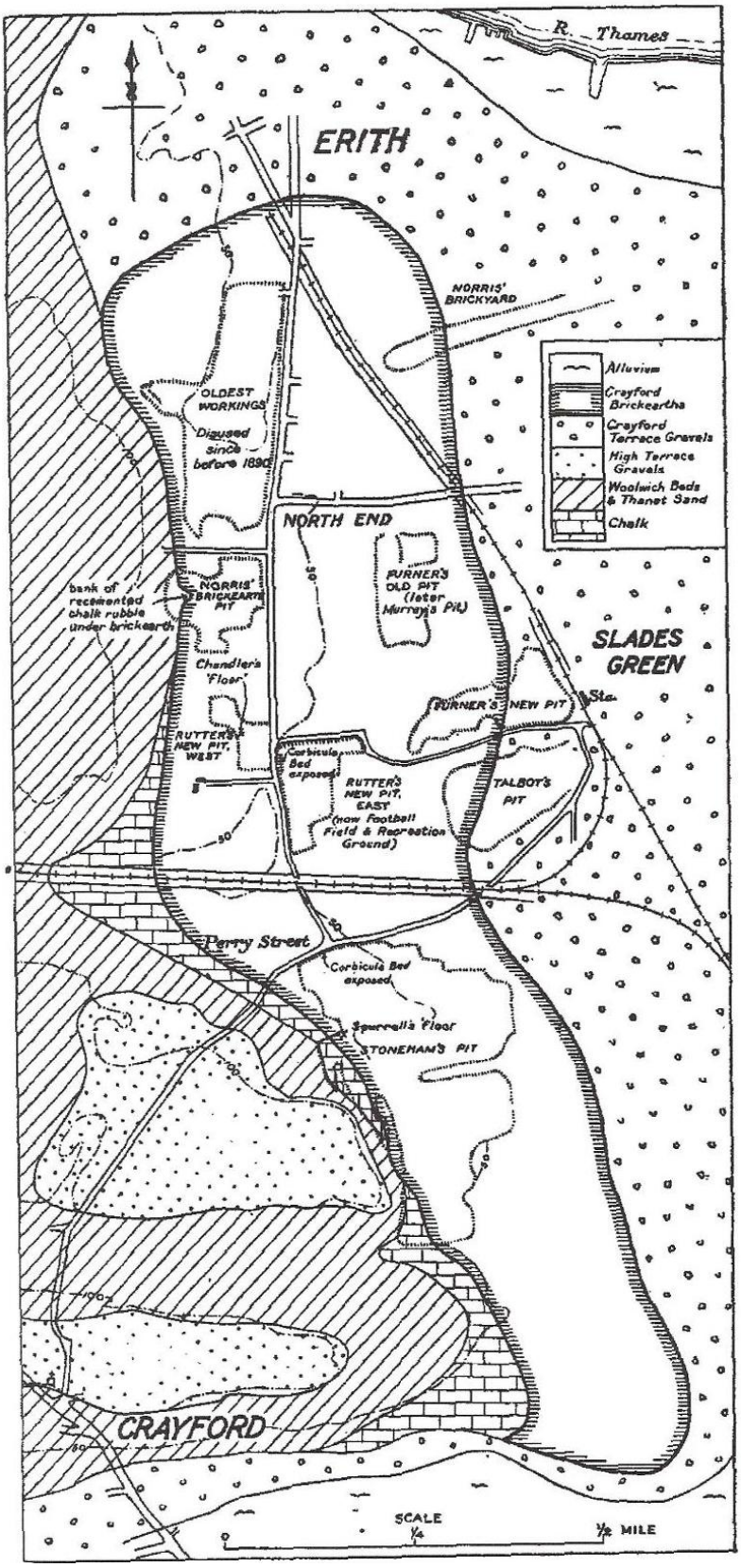
A number of pits cut into the Crayford Brickearth became known for their faunal material from the 1830s (Scott *et al.* 2011) and Flaxman Spurrell first prospected at Crayford with his father Dr. F. Spurrell, an avid fossil collector. Only eight Crayford pits can now be accurately re-located (Kennard 1944) including Stoneham's Pit, where Spurrell found his 'chipping floor'.

In 1880, Spurrell discovered several *in situ* 'chipping floors' in the brick-earths in Stoneham's Pit, Crayford, under a Chalk cliff on a sandy beach of the ancient river Thames (Spurrell 1880a;1880b; 1883; 1884; White *et al.* 2006). One 'floor' extended 10 feet (3.05m) north to south, by 15 feet (4.5m) east to west and the 'chips' included large and small flint flakes, minute chips, cores, spoilt *hâches* (hand axes) and hammers (Spurrell 1884). What Spurrell identified as representing handaxe manufacture is now more commonly attributed to the Levalloisian (Scott *et al.* 2011).

Spurrell began almost immediately to refit the material he collected, demonstrating that the knapping had been done on the spot and the remains were still in primary context (Spurrell 1884). Analysing the distribution of the 'chips', he concluded the knapper had been sitting down to work.

In 1881, Spurrell also discovered a Levallois site in Southfleet pit Northfleet, Kent, now known as Baker's Hole. This site has produced the most substantial British Early Middle Palaeolithic (MIS9-7) assemblage known, mostly Levallois cores and flakes (Scott 2010) at a time when these were being largely overlooked by collectors in pursuit of more aesthetically pleasing handaxes. Spurrell (1884) christened them "turtle-backed flakes".

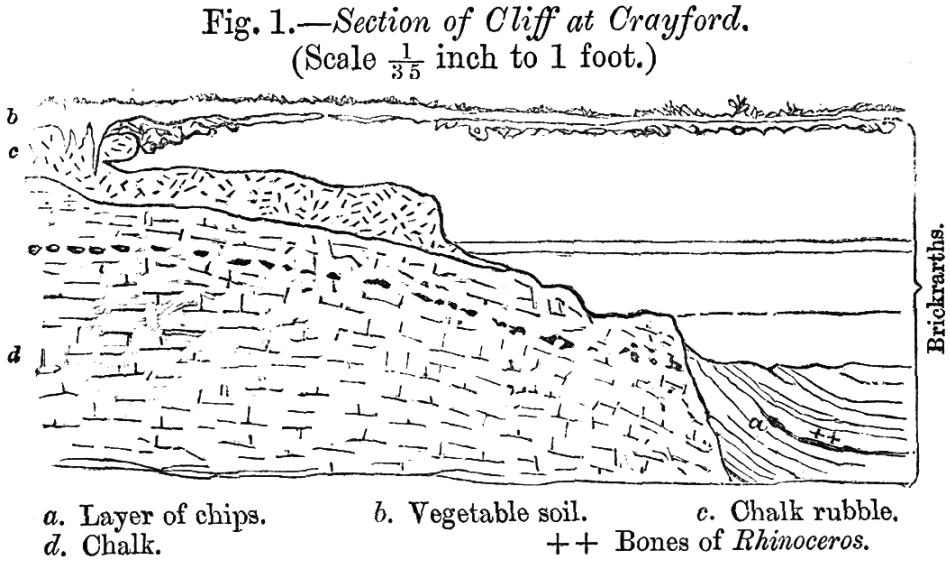
Fig. 7.2 The Crayford brickearth pits



. (Reproduced from Kennard 1944. Fig.12. With permission of the Geologists Association).

Spurrell published little on his findings at Crayford and Northfleet, but his knowledge of knapping and re-fitting of flakes drew attention to what would later be called 'Levallois' flake technology on his Northfleet 'floor'. His collecting activities approached the outstanding standards of W.G. Smith (Roe 1981,24).

Fig. 7.3 Spurrell's section of the cliff at Crayford.



Spurrell successfully refitted the 'chips' to the cores from which they had been struck. (Reproduced from Spurrell 1880b Fig. 1).

At Crayford and Baker's Hole, Spurrell discovered two of the most important Early Middle Palaeolithic British sites (Scott and Shaw 2009) which still dominate research into the period. His meticulous collecting practices and refitting activities allowed him to demonstrate their primary context status and inspired Worthington Smith and other collectors to do the same. However, the practice of grouping finds in particular pits in the SRPP/TERPP database means only 11 findspots are attributed to him in the data, limiting my ability to demonstrate his impact on findspot distribution maps.

James Cross

Although it was Spurrell who first identified the Bakers Hole site, collecting only really began there when Associated Portland Cement Manufacturers Ltd (APCM) extended the pit in 1907, one of the principal collectors being James Cross of Camberwell. A Fellow of the Geological Society, Cross paid weekly visits to the Thames valley pits and put together an immense

collection from Bakers Hole (Abbott 1911). A large quantity of material from the site was also amassed by the APCM, recovered by their employees during the course of their work (Scott 2010; Smith 1911).

Alexander James Montgomerie Bell (1845-1920)

Another active collector on the North Downs was A.M. Bell, a classical scholar and teacher, enthusiastic amateur archaeologist, natural historian and anthropologist. Born in Edinburgh in 1845, Bell is best known today for his later archaeological work at the Lower Palaeolithic site of Wolvercote, Oxfordshire (Bell 1894a; 1894b; 1904; McNabb 2012).

Graduating from Oxford in 1869, from 1877-1890 Bell taught at Limpsfield School, Surrey, where his interest in Palaeolithic implements began. Concentrating on a few sites close to his home, Bell acquired his first Palaeolithic tools from gravel pits in the Limpsfield district in 1883, deposited, he believed, as a result of drifting icebergs (Bell 1884;1904).

Bell's Limpsfield sites were not on the Chalk but on and around Limpsfield Common, on the soliflucted gravels and Head slumped down off the Chalk escarpment onto the Lower Greensand or Weald Clay (Wymer 1999). In total, he amassed 961 objects from the area, virtually all surface finds or (less frequently) from within the superficial deposits (Field *et al.* 1999; Pitt Rivers Museum http://england.prm.ox.ac.uk/englishness-Bell-collection.html). Most of the objects - 558 pieces including 441 bifaces – are Palaeolithic, with a high percentage of twisted ovates – more than 63% at Ridlands Farm (TQ 422 522). That there are fewer than 100 flakes out of the 558 pieces possibly reflects collector bias, although Bell did recover some flakes methodically, noting their findspots (Field *et al.* 1999). Although continuing to collect Palaeolithic implements around Limpsfield from 1883 until 1906, >50% of Bell's collection was amassed between 1885 and 1891 (Field *et al.* 1999).

By 1884 Bell was corresponding regularly with Benjamin Harrison (Ightham is only 14.5 km to the east of Limpsfield, on identical geological beds) and was one of the first of his scientific friends to accept the anthropogenic nature of his eoliths (Harrison 1928, 127; McNabb 2012, 224), publicly advocating their cause in his 1892 and 1894 addresses to the BAAS. He also defended them in print (Bell 1894c; 1898).

Whether Bell collected artefacts himself or bought them from the gravel diggers is unclear, but he does not seem ever to have excavated any sites (http://england.prm.ox.ac.uk/englishness-Bell-collection.html). All his artefacts are marked in pencil, usually with at least the site name and sometimes additional information such as height O.D. and date found (Field *et al*. 1999).

The potential impact of the early collectors on the archaeological record of the areas in which they were active is evidenced by the fact that, if Bell's 12 sites are excluded, the number of findspots in the Limpsfield Common area drops from 17 to 5. All were found by modern fieldwalking in response to Bell's demonstration of the area's potential.

The large number of artefacts found by Bell on the soliflucted gravels and Head deposits at Limpsfield demonstrate clearly that it is not only findspots actually on the Chalk plateaux that should be considered when assessing early human upland presence. Rather, finds now lying in soliflucted deposits at lower levels on the valley sides must also be taken into account if misinterpretations are to be avoided. In Chapter Nine I will separately analyse finds made on soliflucted Head deposits, as well as those in other geological contexts.

Henry Stopes (1852-1902)

Stopes is a largely unknown 19th century antiquarian, who made no seminal discoveries, carried out no ground-breaking methodological work and devoted the majority of his energies to the promotion of Tertiary Man and the Eolithic cause (Wenban-Smith 2009). Despite this, the sheer scale of his collecting activities made a major contribution to the archaeological record of the Lower Thames valley.

Born in Colchester in 1852, Stopes joined his father in the family brewing business in 1871. A passionate fossil collector from a young age, he was elected Fellow of the Geological Society in 1874, Fellow of the Royal Historical Society in 1876 and later became a Freeman of the City of London. A regular attendee and frequent speaker at the annual late summer meeting of the BAAS Stopes was, by his mid-twenties, the complete package of brewer, engineer, architect, geologist and antiquarian (Wenban-Smith 2004a; 2009).

The first handaxes at Swanscombe were found in 1885 and from about this time Stopes began to amass his collection (Wymer 1968). In the early 1890s, following business and health difficulties he moved to Swanscombe, deliberately chosen as a good centre for flint-collecting activities. There he devoted the last 10 years of his life to accumulating possibly the most substantial private collection of lithic artefacts ever collected (Wenban-Smith 2009,69). At its peak this contained 100,000-200,000 specimens.

Kent was Stopes' main collecting area and there are 175 Kent entries in Stopes' catalogue, representing 92 sites (Wenban-Smith 2004a). Mostly in the Swanscombe and Ightham areas, these yielded >24,000 items including >5000 handaxes, 4000 of which came from the Great Pit Milton Street, Swanscombe, later known as Barnfield Pit.

Stopes was the first researcher to promote the significance of the drift deposits at Swanscombe in a stratigraphic context, following his discovery and description (Stopes 1900a; 1900b) of the Greenhithe Shell bed in Dierden's Pit (Ingress Vale), ~0.5 km (547 yards) to the north of Barnfield Pit. This shed light on important aspects of the fluvial, sea-level and archaeological histories of the Thames during MIS11 (White *et al.* 2013). The bed's rich molluscan fauna was stratigraphically associated with palaeoliths and the occurrence of the 'Rhenish suite' of freshwater molluscs in the middle gravels at Barnfield Pit and throughout the Shell bed, provides a secure basis for correlation of important archaeological horizons at Swanscombe (McNabb 2012; White *et al.* 2013). The fact that the 'Rhenish fauna' is an important component of the Middle Gravel at Barnfield Pit and in the Shell bed at Dierden's Pit enables secure correlation between these and other sites at Swanscombe, including Rickson's Pit and the Southfleet Road elephant butchery site (White *et al.* 2013). Dierden's Pit was open for a relatively short period, from April 1899 to some time before 1913, by which time buildings had been constructed on the footprint of the pit, limiting the opportunities for research. Had Stopes failed to identify and draw attention to the Shell bed's significance within weeks of the pit's opening (Stopes 1899), it may have gone unappreciated and been lost without investigation.

Stopes kept a relatively detailed catalogue of his collection (Wenban-Smith 2009), within which each item was assigned and marked with an identifying

site or source number. All items with the same provenance thus shared the same number. How/when an item was obtained was also noted in the catalogue, sometimes with a short description and occasionally the specific stratigraphic context. The scale of Stopes' collecting activities on the archaeological record helped substantially to create the apparent 'super-site' at Swanscombe.

Fig. 7.5 Henry Stopes

(Reproduced from Wenban-Smith 2004a Fig.2).

The Stopes Palaeolithic Project (Wenban-Smith 2004a Appendix 2) lists ninety-one individual Stopes findspots in the Swanscombe area, each with an NGR, but the acknowledged confusion with the names of the various pits and recorded provenances of artefacts in the SRPP database made it impossible to extricate these from my Chalk uplands Palaeolithic dataset to demonstrate this on a map.

iii) The Chilterns

Worthington George Smith (1835-1917)

Worthington Smith was "…an outstanding example of the best of the early amateurs..." (Roe 1981, 24). Born in Shoreditch, Islington in 1835, Smith became a trained architect, expert draughtsman, freelance illustrator and engraver who illustrated all his own work. He married in 1856, living first in Shoreditch and then, from 1885 until his death in 1917, in Dunstable, Bedfordshire.

In 1878 Smith identified traces of a palaeolithic land-surface around Stoke Newington Common, near his home. Over the following years he kept "a record of the exposed surface of every drain, house foundation, pit, &c…" (Smith 1894, 191) establishing the 'floor's extent across 4.82 to 6.43kms (three to four miles). It contained not only flint implements and flakes but also faunal remains and two four-foot long birch strakes, artificially pointed at one end (Smith 1894, 268).

Following his move to Bedfordshire, Smith began monitoring fourteen brickearth pits on the Chalk uplands around Luton and Dunstable (Sampson 1978) a practice he continued for 30 years. At Caddington, on the Chalk dipslope 4.83kms (three miles) to the south-east of Dunstable, at least seven pits were being worked in 1888 (Smith's Pits A-G), of which two were gravel pits, the rest producing brickearth. Smith visited the Caddington pits at least monthly until 1905 and more frequently when a claypit face was being dug back through a major artefact horizon. From Pit C (the "Cottages" site) alone, between May 1889 and December 1895 he was recovering an average of 31.8 artefacts a visit (Hosfield 1999, 195). A skilled observer, Smith did not carry out his own excavations but trained a number of trusted workmen to recognise flaked flint, so that the working faces of the major pits were continuously monitored even in his absence (Dyer 1978; Sampson 1978). As a result he most often worked from photographs of sections taken by his son, a commercial photographer, rather than from the physical sections themselves (Dyer 1978, 143; Hoare and White 2017; White *et al* 1999).

In March 1890, in Pit C, Smith at last found what he considered a continuation of his Stoke Newington Palaeolithic land-surface (Dyer 1978; Smith 1894). Smith was wrong about this, the brickearths being actually the

separate infillings of lakes and ponds formed in individual dolines (White 1997; White *et al.* 1999). Nevertheless, few Lower Palaeolithic sites in the world have produced larger quantities of conjoinable flakes or clearer evidence of a virtually undisturbed Acheulean manufacturing site (Roe 1978, ix).

Fig. 7.5 Worthington Smith indicates a Palaeolithic level in Pit A, Caddington.

In June 1889 Smith found his first in situ Caddington implement here in Pit A. (Image courtesy of The Culture Trust, Luton).

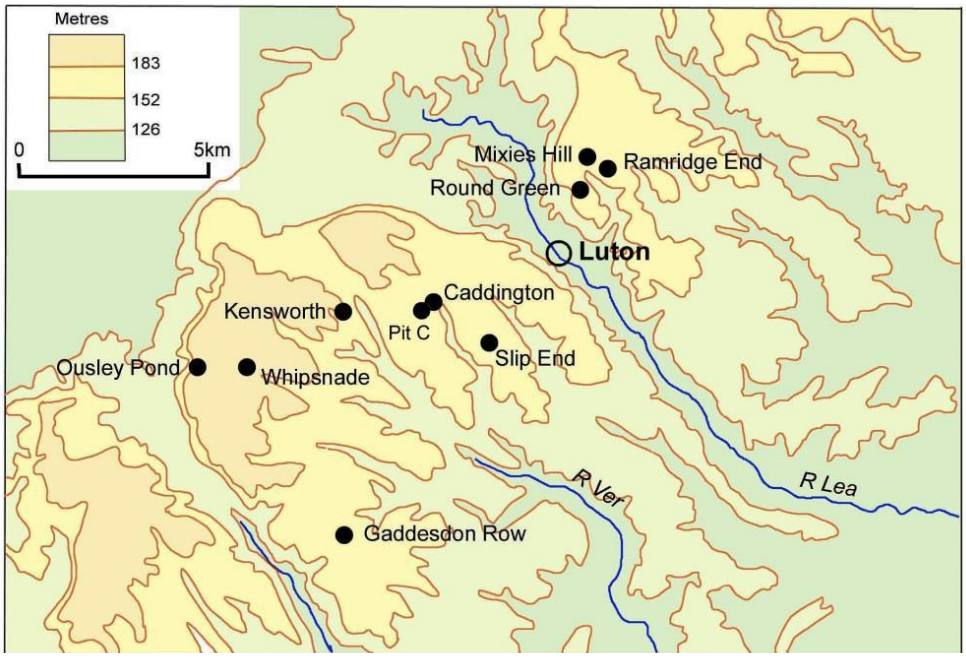
Other important Smith sites in the area include Round Green, Gaddesden Row, Whipsnade and Mixies Hill, where a human skeleton, possibly of Acheulean age was destroyed during removal by the labourers (Scott-Jackson 2000; R.A. Smith 1919; W.G. Smith 1894; 1906; 1916; White 1997; White *et al.* 1999; Wymer 1980).

Unlike most of his contemporaries, Smith rigorously collected and recorded even the smallest débitage and retouched flake tools although, as he invariably visited the pits on foot and carried home any artefacts found, he tended to leave behind the heavier cores and flaked blocks (Sampson 1978; White *et al.* 1999). The round trip to the Caddington pits was a

journey of 9.7 kms (6 miles), about 161 kms (10 miles) to Gaddesden Row and to Round Green about 19.31 kms or 12 miles (Dyer 1978).

Every noteworthy flake and implement in Smith's collection was labelled and recorded in his manuscript *List of Palaeolithic Implements* (LPI). Each was marked with the findspot, month and year of finding, catalogue number of the major items and Worthington Smith's initials (Hoare and Ashton 2016), "… a model of diligence which has made his collection one of the most valuable in Britain" (Wymer, 1968, 291). Almost every implement was carefully and clearly drawn and many were later engraved and published (Dyer 1978). By Victorian standards, Smith's collecting and recording methods were impeccable (White 1997). Like Spurrell, he was particularly interested in the possibility of refitting his finds to try and reconstruct the activities at each site.

Fig. 7.6. Map of the north Chilterns showing the location of Worthington Smith's principal sites.



(Reproduced from Hardaker 2017 Fig.19. With permission of the Geologists' Association)

A prolific author on various subjects including local history, geology, archaeology, botany, architecture and rural crafts (Sampson 1978) Smith became an authority on fungi (Dyer 1978) and spent much time working on the British Museum of Natural History's mycological and botanical collections (Roe 2009). In 1894 he published *Man the Primeval Savage; his*

haunts and relics from the hill-tops of Bedfordshire to Blackwall, "…still a remarkable book by any standards…" (Roe 1981, 31).

Unlike many collectors, Smith never sold his artefacts, though gave many away to fellow collectors (Sampson 1978). Until 1915, aged 80, he was still visiting the pits at Caddington, Round Green and Gaddesden Row regularly on foot, as well as other less important sites (Dyer 1978).

For 40 years from 1878 Smith corresponded with Benjamin Harrison, often on the subject of eoliths, knapped by what Smith called "mythical Pliocene men" who, he concluded, had never existed (Smith 1907; 1908; 1909). Flaxman Spurrell also became a friend (Hoare and White 2017).

Fig. 7.7. Smith's illustration of refitted flakes from Gaddesden Row, showing his labelling system

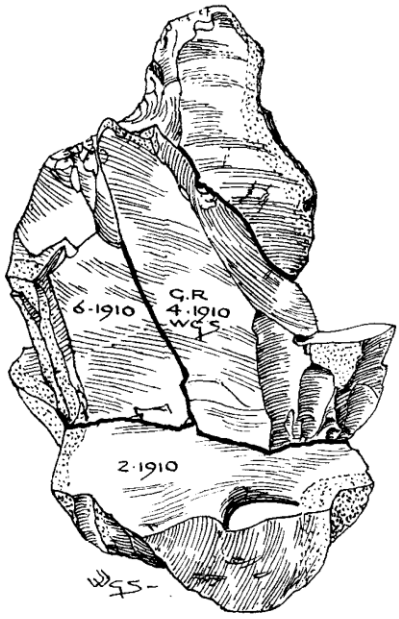


Fig. 24. Three flakes refitted, Gaddesden Row. (⅔)

(Reproduced from Smith 1916 Fig. 24).

In 1865 Smith was awarded the Banksian Medal by the Royal Horticultural Society for his flower drawings. In 1868 he was elected a Fellow of the Linnaen Society (Dyer 1978, 160) and was official draughtsman for the Cambrian Archaeological Association. In 1902, nominated by Sir John Lubbock and Sir John Evans, Smith was awarded a Civil List pension of £50 p.a. for his "services to archaeology and botanical illustration, and his

insufficient means of support". He was made First Freeman of the Borough of Dunstable in 1903 (Dyer 1978).

Although Smith's view of the geology of his sites was seriously flawed (White 1997) his research represents a pinnacle of Victorian antiquarian endeavour and his discoveries had a major impact on the archaeological record, not just regionally but nationally. The survival of environmental evidence from Lower-Middle Palaeolithic sites is vanishingly rare. Although unable to salvage them, Smith recorded animal bones and deer antler at both Mixies Hill and Biscott (Smith 1894,168) while his meticulous collecting practices meant that pollen extracted from particles of brickearth preserved on flakes he collected at the Cottages site allowed the reconstruction of environmental conditions at the time was plateau occupied (Campbell and Hubbard 1978). Without Smith's assiduous monitoring of the Caddington and Luton pits, these internationally significant sites would have been lost without record. Of only five *in situ* Acheulean sites in Britain listed by Roe in 1968 four had been discovered by Smith – Caddington, Gaddesden Row, Round Green and Stoke Newington (Roe 1969; White 1997). Even today, only a handful of other sites can be added to this list.

Llewellyn Treacher (1859-1943)

Born 9th February 1859 in Twyford, Berkshire, Llewellyn Treacher gained a wide knowledge of local soils and drainage from his work in the family's market gardening business. During the 1880s he became interested in collecting palaoliths, finding his first in 1888 on the surface of a field near Ruscombe brickyard. On the advice of Joseph Stevens, honorary curator at Reading Museum, Treacher began watching all the active gravel pits in the neighbourhood, his collecting activities developing steadily until he was regularly visiting more than 50 pits between Reading and Slough. These included key sites such as Cookham Rise, Bakers Farm, Dorney Wood and Furze Platt upper and lower pits (Cranshaw 1983). He also acquired implements from the prolific pits in the Wallingford Fan Gravels (Arkell 1943-44; Wymer 1968).

A keen photographer, Treacher took >900 photographic plates between the 1890s and 1930s, primarily of pit sections in Twyford and the surrounding area (Cranshaw 1983). Although sometimes inspecting the gravels himself,

much of Treacher's collection was bought from quarrymen whom, like other collectors, he trained to recognise flint implements (Dewey 1944). By 1897 he had amassed >300 Palaeolithic implements from the pits between Cookham Rise and Maidenhead alone (Treacher 1897). The haul from Furze Platt included ~500-600 artefacts, excluding flakes and wasters (Treacher 1905), most collected without any record of their stratigraphic position (Roe 1969). Map 9.4 shows the impact of Treacher's collecting on the archaeological record around Maidenhead.

Treacher concentrated on the finest handaxes, not routinely collecting flakes until late in his career. Of the >2,500 artefacts he collected from Furze Platt only 58 were flakes (Tyldesley 1986, 127). Not so much an archaeologist as a scholarly amateur interested in assiduous collecting (Cranshaw 1983) Treacher was, to some extent, a dealer as well as a collector and in 1911 sold >500 handaxes from Furze Platt to the Royal Museum of Ontario.

Like many other major collectors, Treacher's collection is inadequately supported by field notes, maps or first-hand observations about stratigraphy. He neither inventoried his finds nor arranged them strictly according to site and although he always labelled them, the labels may refer to the pseudonyms given to 'his' pits to put rivals off his track, but to which he, unfortunately, left no key. Thus, the Wolvercote Channel became the Bishopsland Channel, "Tar Pit" was the Kennylands Pit at Sonning Common and "Northfields" may be Northbury Farm, Ruscombe (Cranshaw 1983).

Treacher was not alone in seeking to protect his collecting areas this way. Dr. Armstrong Bowes, of Herne Bay, Kent labelled his specimens with single letter abbreviations for each word of the site name, but used the second letter of the name in each case. Thus, Fordwich became O and Canterbury West was A. E. (Roe 1981). Other examples include the Sussex collectors Reverend Shaw and Dr Higgins, both of whom were secretive about their finds. Shaw often labelled his finds with his home address, rather than their findspot, while Higgins gave his finds coded numbers not site names. Like Treacher's, the key to these codes has been lost (Woodcock 1981).

Treacher published only brief “Notes” on the 25 field trips he led for the Geologists’ Association in the Middle Thames area (Treacher 1896a; 1896b; 1897;1904;1909) plus a few short articles on stone implements and geology. Elected a Fellow of the Geological Society in 1893, in 1913 Treacher received a Lyell Foundation award in recognition of the value of his contributions on the Chalk (White 1943).

The sheer scale of Treacher’s collecting from more than 50 gravel pits between Reading and Slough inevitably had a substantial impact on the archaeological record. The significance of his activities is, however, substantially reduced by his failure to note the stratigraphic position of his finds, his practice of largely ignoring anything other than handaxes and his obscure labelling system.

After his death in 1943 Treacher’s wife donated his collection of >5000 artefacts to Oxford University Museum, publishing it (Treacher *et al.* 1948) with the help of William Arkell, an authority on the Palaeolithic of the Upper Thames and Chilterns.

G.W. Smith (1869–1945).

Among the lesser known collectors on the Chilterns was George Smith, a Caversham banker who collected a large quantity of local antiquities including Lower and Middle Palaeolithic artefacts. His collecting activities extended as far east as Cookham and Maidenhead.

Smith’s extensive local collection, now in Reading Museum, is characterised by a prevalence of ‘choice’ artefacts and rather uneven documentation. Much of his lithic material was unmarked and he had a tendency to ignore flakes (Hosfield 2009). Although producing three volumes of notes and short entries relating to his discoveries between 1885 and 1941 (Wymer 1968) Smith published little or nothing.

Other collectors active in the Reading area included Reverend C. Overy, O.A. Shrubsole, E.W. Dormer and Joseph Stevens (Hosfield 2009; Smith 1915a; Wymer 1968)

iv) South Downs

The South Downs, extending from Beachy Head East Sussex to the Hampshire border, consist of three main physical divisions, the Weald, the

Downs and the coastal plain. Although not a rich area for Palaeolithic discoveries, they have been made in all three contexts (Curwen 1954). With the exception of the Slindon raised beach, the Chalk downlands have produced the greatest number of implements from Sussex (Woodcock 1981) the majority being surface finds. These have come particularly from the Downs between Eastbourne and Brighton, with other sporadic discoveries on the high ground north of the Chalk escarpment (Todd 1934;1936; Wessex Archaeology 1993b). There are no fewer than 150 hill-top palaeoliths from the Friston area in the Hewlett collection in Brighton museum (Garraway Rice 1911; Woodcock 1986).

Due probably to limited commercial exploitation, only a few isolated handaxe finds relate to the Sussex river gravels. The first actual references to material from Sussex river gravels seem to have been by Garraway-Rice in 1905 and 1911 (Wessex Archaeology 1993b) and they have produced only a scatter of implements. Between 1904 when he found his first Sussex palaeolith and 1911, Garraway Rice (1905; 1911) repeatedly searched areas in the west of the county where river terrace gravels were exposed, yet despite monitoring six gravel and sand pits, he found only six or seven Palaeolithic worked flints. Although handaxes have been claimed from the Sussex river gravels, particularly the Arun and western Rother gravels, there is not a single totally satisfactory record of one with a precise and unequivocal provenance (Wessex Archaeology 1993b).

The Solent Palaeolithic record was created primarily during the late 19th and early 20th centuries and curtailed by the introduction of mechanised excavation during the 1930s and 1940s (Hosfield 1999; Fig. 2.20). Although Davis (2013 Fig. A2.1) lists 49 collectors in the Solent region between the 1860s and the 1990s, only 14 are shown as having more than 50 artefacts and only 7 with more than 100. Despite being the Society of Antiquaries Local Secretary for Sussex, R. Garraway Rice collected relatively little in Sussex compared with his work in the Thames Valley. Although there were other Sussex collectors, such as the Reverend Shaw and Dr.Higgins in the Lavant area or Hewlett at Friston (Woodcock 1981) their activities were relatively small scale.

The dearth of finds from the Sussex river gravels changes dramatically in the adjoining part of southern Hampshire, notably in the neighbourhood of

Southampton. Hampshire has yielded more Acheulean finds than any other English county, its record dominated by finds from the river gravels of the Avon, Itchen and Test (Shackley 1981). Those from the Test, which marks the boundary of my South Downs research area, include the hugely prolific gravel pits at Wood Green and Dunbridge (Fig. 7.10). Huge quantities of material have also been recovered from the terrace gravels around Southampton and Bournemouth. However, the large scale collecting of Dale (1912; 1913;1918) in the gravel pits of the Test valley and around Southampton (>600 artefacts) and Herbert Druitt (>1000 artefacts) in the Bournemouth area (Davis 2013; 2014) did not affect the archaeological record of the South Downs Chalk. Nor did that of the lesser collectors on the Warsash gravels, Southampton, foremost among whom was C.J. Mogridge (Davis *et al.* 2016).

Fig. 7.8. Dunbridge pit in operation

Section in Dunbridge pit showing the scale of the operation (scale in yards).
(Reproduced from Dale 1912 Fig.3).

There were dedicated collectors on the North Hampshire Downs, north of my Sussex study area, particularly around Basingstoke. These included W.G. Willis, J.R. Ellaway, H. Rainbow and occasionally O.G.S. Crawford (Scott-Jackson and Winton 2001). There was, however, no intensive collection on the South Downs to rival the concentrated efforts in a

relatively small area of Benjamin Harrison, the Treachers or Worthington Smith.

Grinsell (1929) concluded that the scarce Lower-Middle Palaeolithic record for Sussex indicates the area was more sparsely inhabited in Palaeolithic times than other parts of south-east England and north-east France. It is, however, equally possible that the cause was the absence of serious collectors and dearth of gravel or brickearth extraction on the Downs and in the river valleys.

v) Northern France

Victor Commont (1866 -1918)

The construction of the Canal du Nord during the early years of the 20th century created deep trenches stretching across Picardy and Artois. These were observed with great interest by a number of French collectors, foremost among whom was Victor Commont. His interest in the Palaeolithic first sparked by the exposure of Pleistocene deposits in the Carrière Bultel-Tellier near his home in Amiens, later dubbed "l'atelier Commont", Commont is perhaps best known for his work on the Somme terraces and the quarries of the Abbeville area (*cf* Chapter Two). However, he also monitored the construction trenches of the Canal du Nord, publishing accounts of numerous finds along the route, including those made by other collectors (Commont 1910b; 1911; 1916a; 1916c). Commont's expert advice was acknowledged by his fellow collectors (Salomon 1912b;1912c; Vignard 1957).

Commont established that the area around Catigny (Oise) at the junction of four watercourses, was the crossroads of four natural routes through the landscape, making it an obvious place to look for archaeological sites (Commont 1916a). The Catigny sector of the Canal du Nord, yielded very rich lithic and faunal discoveries, thanks to Commont's precise observations which greatly assisted Vignard with his collecting activities in the area.

Commont published 72 papers and mémoires between 1904 and 1917, many of them concerning Saint-Acheul, and corresponded with other collectors about quarries elsewhere in the Somme Basin (Tuffreau 2001; 2009). His exceptionally precise observations, made at a time when

urbanisation was much less developed, still form the basis of current archaeological work in and around Abbeville and Amiens (Hurel and Coye 2011; Hérisson and Goval 2013) and his stratigraphic scheme for the Somme Valley is still valid and important today (Antoine *et al.* 2011).

Of the 167 French sites identified during my research, Commont can be established as the finder of at least 15, including a number of important ones such as Briqueterie Brocart (Allonne), Carrière Buhant (Montières-les-Amiens) and Bouchavesnes (Somme).

A. Salomon

A. Salomon, director of roads and bridges for the Canal du Nord in the commune of Hermies (Salomon 1911, 1912a; 1912b 1912c; 1913) also monitored and collected from the canal trenches in his area, identifying several significant sites. These include the Mousterian gisements of Les Ruyots (now Hermies le Tio Marché), La Vallée de Bertincourt and Bertincourt. At Bertincourt Salomon also identified an underlying Lower Palaeolithic level and at Ruyaulcourt an Acheulean atelier. At Ruyots, he found 7000-8000 flakes of debitage and hundreds of cores *in situ*, together with several hundred retouched and used tools as well as naturally flaked flints (Commont 1916c). Based on his observations and discoveries, modern excavations in Hermies commune rediscovered the *in situ* site of Hermies “le Tio Marché” (Salomon’s ‘Ruyots’), as well as Hermies “le Champs Bruquette” (Vallin and Masson 2004).

E.Vignard

Between 1909 and 1911, E. Vignard, a chemist in the Ercheu area, spent most Sundays examining the Canal du Nord trenches from south of Catigny to north of Beaurains, sometimes accompanied by Commont. During the course of his investigations he discovered several important Mousterian sites, including those of Catigny, Sermaize and Béhancourt. Commont was able to refit two flakes from Béhancourt, convincing him there must be an important Mousterian site nearby. Vignard also found 110 ‘coups de poing’ (handaxes) at Catigny, between milestones km19 and km 18.8 of the Canal du Nord, plus 42 more at the Pont de Catigny. The remains of raw material blocks lay close by (Commont 1916a; Vignard 1957).

For reasons explained in Chapter Four, I was unable to access the digital data of the Bureau de Recherche Géologiques et Minières (BRGM), the equivalent of the British Geological Survey (BGS). As a result, I could not carry out the same detailed mapping of findspots against their geological context for my French sites as I did for my British data. The thick loess covering in Northern France compounded this problem, making it impossible to map findspots against the underlying Clay-with-flints. I have, however, analysed the impact of the French antiquarian collectors on the archaeological record. Of my 167 sites in the Hauts-de-France region, a total of 29 (17%) were first identified by them.

vi) Summary

Although there were notable later collectors in my study areas, such as Leslie Carpenter on the Surrey Downs and Peter Tester in Kent, in this chapter I have reviewed the work of those antiquarians active during Gamble's "Age of the Collectors". It was they who made the greatest number of finds, with the greatest impact on the archaeological record, but who with one or two exceptions recorded the least detail about those finds.

I have identified a number of factors affecting the archaeological record as a result of antiquarian preferences and collecting practices. These include:

- Increased collecting activity at known prolific sites such as Swanscombe and Dunbridge, resulting in the creation of apparent 'super-sites';
- Selective recovery of particular artefact types, with a heavy bias towards Lower Palaeolithic handaxes;
- Transfer by workmen of artefacts from prolific pits to sites where they were rarer and, therefore, more valuable;
- Networks of trained workmen established by collectors at quarries and building sites are unlikely to have provided equal coverage of all potential sources of Palaeolithic material;
- Accessibility by transport links and remoteness of sites would have affected collecting activities, limiting collectors such as Harrison and Smith to the return distances that could be walked in a day. Development of the railway network in southeast Britain made many sites more accessible, with an impact I assessed in Chapter Six.

- The nature of the evidence for the Palaeolithic period in the counties of south-east Britain is problematic, with large collections of artefacts accumulated by Victorian clergymen with a fondness for afternoon strolls in gravel pits (Shackley 1981) but who seldom recorded exact findspots and stratigraphical positions. The problem is compounded by their fondness for codes and cyphers, making many sites now difficult to identify securely.
- The working practice of hand-digging away at the base of gravel layers until the undercut gravels collapsed into the pit (Cranshaw 1983) means the majority of the implements were collected by the workmen when shovelling the fallen material (Dale 1912; Treacher *et al.* 1948). Consequently, stratigraphic information was either unobtainable or imprecise.
- There are clear differences in the impact of antiquarian collecting between southeast Britain and northern France, largely because of the geomorphological differences between the two countries. In Britain the archaeological record consists predominantly of surface finds, with buried *in situ* sites such as Crayford and Caddington identified only rarely. In France, the dense loess coverage is penetrated only by construction works such as the Canal du Nord, limiting collecting opportunities and making surface finds extremely rare. French antiquarian collectors predominantly identified *in situ* sites such as Hermies le Tio Marché and Ruyaulcourt.

The collectors discussed in this chapter were all members of the middle-classes. While the upper classes were collecting Greek and Roman antiquities, the question of the antiquity of man and the identification of humanly-worked flints in ancient gravels was primarily dependent on understanding and diligence, rather than unfettered resources of time and money (Wenban-Smith 2004a). Collecting Palaeolithic artefacts fitted the pockets and time-constraints of the middle classes perfectly, allowing them to buy into the scientific and intellectual achievements of the Victorian era. The Palaeolithic collections in most museums in Britain are dominated by Lower and Middle Palaeolithic material thanks to their preferences and collecting practices and the general focus of 19th and early 20th century research on the oldest finds (Roberts 2013).

While varying greatly in their collecting and recording standards and despite the associated limitations and interpretational difficulties it was, ultimately, the behaviour of collectors that has shaped the secondary context archaeological record as we now see it (Davis 2013, 66). It is, therefore, crucial that that behaviour is understood and its impact on the archaeological record taken into account in interpretations of early human landscape preference.

Chapter Eight. Differences between English and French national heritage management policies and strategies.

i) Introduction

Palaeolithic archaeology is often deeply buried, difficult to identify and contained in Pleistocene deposits that most archaeologists would term the 'natural'. As such, it is particularly vulnerable to destruction during development work and infrastructure construction, unless adequately protected by robust heritage management policies. As part of my research I therefore set out to identify any differences between British and French Government heritage management policies and strategies and to assess their actual and potential implications for the Lower-Middle Palaeolithic archaeological record of the Chalklands. In this chapter I will consider the differences between the official regimes of the two countries. In Chapter Nine I will present the results of my detailed analysis of the differences between their archaeological records as a result of those regimes.

Even at first glance there are significant differences between the ways in which the Lower-Middle Palaeolithic Chalkland archaeological records of England and France have been created. For example, 59.3% of my French dataset entries are the result of officially authorised fieldwork, whereas for England the figure is only 5.1%. The terms 'developer-led' or 'planning-led' archaeology are used in England for what is, in the rest of Europe, called 'preventive archaeology'. Preventive archaeology, which has replaced rescue archaeology, has been defined (Depaepe and Salas-Rossenbach 2013) as archaeological research specific to the detection and study of archaeological remains threatened by development works. This difference in terminology reflects the difference in relative importance placed on archaeology by the British and French states.

ii) England

Legislative background and administrative arrangements

The UK system for heritage management, including archaeology, has two essential parts: first the identification of heritage through designation by Historic England under the 1979 Ancient Monuments and Archaeological Areas Act, (covering scheduled ancient monuments, listed buildings, registered parks and gardens, registered battlefield and wrecks) and,

second, protecting it through the planning system. By default, sites that comprise only groups of objects or other deposits providing evidence of human activity during early prehistory cannot be scheduled because they are not deliberately created structures, features or remains. This automatically excludes all Lower-Middle Palaeolithic surface sites, even the globally significant Boxgrove, from statutory protection and means caves are the only type of early prehistoric site that can presently be scheduled. Currently, the Schedule includes just over 50 sites in England with significant Palaeolithic or Mesolithic remains, of which 40 are caves or rock shelters (Historic England 2018). However, caves were rarely occupied during the Lower-Middle Palaeolithic and do not, in any case, occur on the Chalklands of my study areas.

Current planning legislation does allow for Lower-Middle Palaeolithic surface sites to be accorded equal significance with Scheduled Monuments and treated as if they have designated status, provided they can be shown to be of national importance. Assessment of importance depends on the extent to which the evidence in a particular deposit can contribute to addressing national and regional research priorities and the criteria for defining nationally important Palaeolithic sites were set out in Historic England's 1998 guidance document *Identifying and Protecting Palaeolithic remains*. Since archived by Historic England and not directly replaced, these criteria are nonetheless cited in Historic England's 2018 *Scheduling Guide for sites of early human activity*, which acknowledges that the nature of such sites means they are often particularly fragile and vulnerable, making their identification and protection by means other than scheduling a priority.

Nine criteria for national importance were listed in 1998, of which seven are applicable to the Lower-Middle Palaeolithic. These are:

- Presence of human remains
- The remains belong to a period or geographical range where evidence of human presence is particularly rare
- Presence of organic artefacts
- Well-preserved environmental indicators directly related to the evidence of human presence
- Evidence of human activities – e.g. butchery

- Clearly stratified deposits containing Palaeolithic remains
- Evidence of resource exploitation, such as raw material
- Abundant artefacts

For substantially disturbed or reworked Palaeolithic sites to be considered nationally important requires either exceptional evidence or that at least three of these criteria are met. There would, therefore, be considerable difficulty in gauging the eligibility of the many lithic scatters recorded in HERS for national importance status without a considerable amount of research including, possibly, revisiting sites in the field (Oxford Archaeology North 2015).

Pleistocene early humans cannot be understood independently of their environment (Historic England 2018) yet these criteria make no reference to the potential archaeological significance of surviving Pleistocene deposits *per se.* Even without direct association with evidence of human activity, these can provide valuable information about the Lower-Middle Palaeolithic environment and should be recognised as a cultural resource in their own right (Wenban-Smith *et al.* 2007). They are also markers of where Palaeolithic archaeology might be found nearby.

Historic England is purely an advisory body and its guidelines are subordinate to government policy, with decisions on national importance guided by Principles of Selection laid down by the Secretary of State for Digital, Culture, Media and Sport (DCMS). These cover period, rarity, documentation/finds, group value, survival/condition, fragility/vulnerability, diversity and potential (DCMS 2013). Neither the DCMS nor the Ministry of Housing, Communities and Local Government, which is responsible for planning matters, directly employs any archaeologists.

Only five percent of England's archaeological sites are designated, or formally protected by law (Council for British Archaeology 2017). The rest are dependent on the local authority planning system for their care and protection. Local planning authorities also have the power to designate conservation areas, locally list buildings and archaeological sites within their area and incorporate these in their planning decisions. There is at present no rigid methodology in place for dealing with lithic sites in the planning process and it is usually left to the discretion of individual local

planning authorities whether any form of evaluation and/or recording is undertaken.

Between 1950 and the 1990s, many important archaeological sites in England were destroyed by new development without proper, or sometimes any, record. Partly as a result, Planning Policy Guidance Note 16 on Archaeology and Planning (PG16) was issued in November 1990. This recognised the significance of heritage on the ground and charged local authorities to withhold planning permission until the archaeological effects of any proposed development were clear. Developers were required to undertake desk-based research, field evaluation and, when necessary, excavation. When present, important remains were to be preserved if at all possible. In other cases, development could proceed after excavation and recording. Responsibility for paying for this work now lay with the developer, not with public agencies, a change which has been described as 'enabling the state massively to withdraw from funding archaeology, effectively privatising it' (Brenan 1994,395) or, alternatively, 'reducing our reliance on state funding' (Flatman and Perring 2012, 4). Local authority archaeological officers were charged with assessing what was required and checking that it was done properly. The result was a proliferation of commercial archaeology units, including archaeology field units which had previously received grants to carry out 'rescue excavations' (Brenan 1994) and by 2012, 59% of archaeologists in the UK were working for commercial private sector organisations (Hook *et al.* 2016). Since 1990, developer funding has resulted in an almost 10-fold real-terms increase in the resources available to England's archaeologists, with more than 75,000 archaeological interventions instigated as a result of the requirements of the planning system (Trow 2016).The number of significant Lower-Middle Palaeolithic finds made as a result has, however, been vanishingly small.

The 'polluter pays' principle introduced by PPG 16 and its successors created a positive economic pressure to minimise archaeological impact and hence cost (Allen 2016). Unfortunately, developer-led archaeology is the only economic activity where the client has no interest in buying the product (Depaepe 2016) and developers do not want to buy the best archaeology. They simply want a company that will release their land as soon as possible and at the least cost (Demoule 2016).

From 2002 until 2011, Lower-Middle Palaeolithic archaeology enjoyed significant funding as a result of the Government's Aggregates Levy Sustainability Fund (ALSF) on sales of primary marine and terrestrial resources. During that period the Department for Environment, Food and Rural Affairs (Defra) funnelled a proportion of the revenue generated by the levy through several delivery partners, including English Heritage (now Historic England). In total, English Heritage directed almost £8.8 million to Lower-Middle Palaeolithic archaeology and wider Pleistocene research during that nine years, allowing its showcasing on the international scene. ALSF not only resulted in a more comprehensive knowledge about the Pleistocene in regions affected by aggregate extraction. It also helped synthesise large datasets (e.g. the Stopes Palaeolithic Project) that might otherwise have remained dormant and greatly enhanced the local Historic Environment Registers. The results benefitted archaeologists, development controllers, curators, HER officers and academics (White 2016a; 2016b), making it difficult to overestimate the levy's importance. Perhaps predictably, since its demise it has not been replaced with alternative funding.

The National Planning Policy Framework (NPPF) published in 2012 by the Ministry of Housing and Local Government (revised 2018 and updated 2019) (https://www.gov.uk/guidance/national-planning-policy-framework) sets out the British Government's current planning policies for England and how these are to be applied by local authorities through their planning processes. It subsumes the principles of PPG16 and its 2010 successor Planning Policy 5 (PP5 – Planning for the Historic Environment). Chapter 12 (paragraphs 126 to 141) deals with conserving and enhancing the historic environment, including archaeology. A 'heritage asset' is defined as 'a building, monument, site, place, area or landscape identified as having a degree of significance meriting consideration in planning decisions because of its heritage interest. One of its core principles is the conservation of such assets 'in a manner appropriate to their significance'. This 'heritage asset' definition should encompass surviving Lower-Middle Palaeolithic archaeology but the emphasis throughout is on the *known* (my italics) significance of an asset, leaving areas of archaeological potential but unknown/unproven significance potentially vulnerable. This is particularly true of the Lower-Middle Palaeolithic resource which is not easily identified

by archaeological methods of surface survey. My project to address this problem by testing the feasibility of locating solution hollows containing *in situ* Middle Pleistocene deposits through the use of electromagnetic and electrical resistance tomography survey, part-funded by a grant from the Quaternary Research Association, is described in Appendix 1 (Blundell 2017).

Although giving archaeology equal status with other planning considerations in a core policy document for the first time, the NPPF states categorically that the purpose of the planning system is to contribute to the achievement of sustainable development and its central theme is the presumption in favour of sustainable development. (https://www.gov.uk/government/collections/revised-national-planning-policy-framework). Chapter 16, paragraphs 184-202 deal with conserving and enhancing the historic environment. Paragraphs 189 - 192 deal with designated heritage assets. It has been described (Flatman and Perring 2012) as being entirely process driven, treating archaeology as an 'issue' to be resolved by the planning system, ideally at the lowest possible cost.

Archaeological resources at the local and national levels

According to Historic England's 2018 *Scheduling Guide*, sites identified as nationally important are protected through the planning system, with local authorities playing a key part in managing them through their archaeological services and Historic Environment Records. This is disingenuous, given the severely weakened state of those services.

The significance or otherwise of a 'heritage asset' can only properly be addressed if there are enough suitably qualified and experienced staff in local planning authorities to examine planning applications, yet in many authorities this expertise is now at a critically low level (RESCUE 2012). Following the introduction of PPG16 in 1990, a 1994 census of County Archaeologists in England identified a dramatic increase in their workload, with PPG16 creating far more work on the planning side of archaeology but no change in funding to support this. In general, Historic Environment Register (HER) staff were increasingly forced to spend more time on development control than on updating and enhancing the HER (Bradley 1995).

The replacement of PPG16 by PP5 then by the NPPF did nothing to alleviate these pressures, particularly when coupled with the ever-increasing demand for development land (especially in the southeast of England) and the very substantial cuts in local authority services over the past few years. Archaeology services in England, including HERs, are non-statutory and most archaeological planning advice is provided not to the parent or host authority but to external local authorities through funded service level agreements or other partnership arrangements. These services are, therefore, especially vulnerable to funding cuts, particularly in comparison with statutory and more visible front-line services. As a result, budget reductions resulted in a 20% fall in the overall number of staff, from 410 in 2006 to 336 by 2013 (Association of Local Government Archaeological Officers: England 2014) and the number of historic environment specialists providing advice to local government is now down by >32% (Council for British Archaeology 2017; Hook *et al.* 2016). In some districts the loss has been as much as 70% (Caruth 2018). Whereas the applied archaeology sector grew by 25% between December 2012 and March 2015, numbers of local authority staff providing advice to planning authorities, the lynchpin of the developer-led archaeology process (Trow 2016) declined by 5.4% (Hook *et al.* 2016). This void in local authority staffing is being filled by the consultants employed by developers, who are hardly impartial and rarely have local or period-specific knowledge (Wade 2018). This is particularly true for the Lower-Middle Palaeolithic.

As part of the NPPF emphasis on the 'significance' of any heritage assets likely to be affected by a proposed development, the level of detail required of a developer to describe that significance need only be 'proportionate to the asset's importance' The minimum required is that the relevant HER should have been consulted and the heritage assets assessed 'using appropriate expertise where necessary'. There is, however, no requirement for that 'appropriate' expertise to be provided by professionally certified or accredited advisers. Evidence – e.g. from the Caddington Cottages site (see page 278) – suggests that HERs are either not being consulted or their contents are being ignored. Poor quality heritage assessments are being submitted, the lack of capacity and expertise in local authorities leaving them unable to challenge these (Caruth 2018). Having identified and assessed the particular significance of any heritage assets that may be

affected by a proposal, local authorities may then require a developer to submit an 'appropriate' desk-based assessment, followed, if necessary, by a field evaluation. This offers little if any protection when many local authorities no longer have expert resources adequate for the monitoring task and where, under commercial considerations, a developer is likely to accept the cheapest, not necessarily the best, tender from a commercial archaeology unit.

Major infrastructure projects

The situation is somewhat better in respect of major rail infrastructure developments such as High Speed 1 (HS1), Crossrail and HS2, or large-scale highways improvements like the A14 Huntingdon to Cambridge scheme. Adequately resourced non-departmental public bodies, sponsored by the Department for Transport and working to Development Agreements made with that Department, are established for major infrastructure projects to oversee the works, with archaeological investigations built into these projects from the start (HS2 2017; Keily 2017). Considerable effort is made in the planning stages to identify important archaeological sites, avoiding or preserving them *in situ* whenever possible.

Between 1996 and 2004, HS1 (formerly the Channel Tunnel Rail Link) generated what was then the country's largest archaeological project to date, overseen by Rail Link Engineering's (RLE) archaeology team. Pre-dating the NPFF, its construction operated within the guidance of PPG16 and its archaeology strategy was devised with the involvement of the then English Heritage, county archaeologists and university academics (Starling 2013). Following desk-based assessment, geophysical survey, field-walking and location-specific trial trenches were commissioned to provide further detail where there was uncertainty, with more than 70 sites undergoing extensive archaeological investigation, analysis and reporting (Starling 213).

For HS2 essentially the same pattern is being followed, enhanced by the addition of a LIDAR survey of the whole route and more than 60 sites have been excavated by >1000 archaeologists during Phase 1. Archaeological research and investigation will continue into the 2030s as Phase 2 is built (Wass 2019). During the actual construction of the line an archaeological watching brief will be carried out in areas where no archaeology was

identified by the desk-based survey *etc.* (HS2 2017) *but only where there is a realistic potential for archaeological discoveries* (my italics). In this context it must be cause for significant concern that a comparative study of geophysical survey and trial trenching on the French Canal Seine-Nord Europe project showed that, in those zones where both methods were applied, 13 sites were found. All were identified by the trial trenching but only three were clearly located by geophysical methods (Hulin *et al.* 2018). The potential danger is greatest in respect of Lower-Middle Palaeolithic remains, which cannot be directly detected by remote sensing techniques, only by scattered lithics and faunal remains. In this context it is significant that of the 60 sites identified as archaeologically significant during the HS2 survey, the earliest dates to the Mesolithic (https://www.gov.uk/government/news/hs2-begins-archaeology-work-exploring-over-10000-years-of-british-history). This is despite the fact that HS2 Phase One crosses the Chilterns AONB through the Misbourne Valley and the dry gap in the escarpment at Wendover, an area that escaped glacial scouring in MIS12 so has high potential for Lower-Middle Palaeolithic archaeology.

For Crossrail (London's new east-west railway), on which work began in 2009, a similarly extensive archaeological programme was undertaken by >200 archaeologists, leading to the discovery of >10,000 artefacts from forty sites. Most of the 42 kms of railway tunnels were dug 30-40m underground, too deep to disturb any archaeology, but wherever new stations and structures were built, where tunnels reached the surface or where the line connected with existing stations archaeological investigation, including excavation, took place. Despite the scale of the excavations, apart from the remains of a partial woolly mammoth jawbone at Canary Wharf and ~68,000 years old aurochs, reindeer and bison remains in an infilled river channel at Royal Oak, the earliest archaeological find was a Mesolithic lithic scatter. In the absence of any on-site Lower-Middle Palaeolithic specialist, the Natural History Museum was called in to advise. Similarly, woolly mammoth and woolly rhinocerous remains were found during work on the A14 Huntingdon to Cambridge improvement scheme, then nothing before the Neolithic, despite more than 40 excavations covering 350 ha (865 acres). In this instance an external consultant Palaeolithic archaeologist was called in to advise. In both cases, expertise

was called in after faunal remains had been found, raising the strong possibility that large areas of Pleistocene deposits full of valuable palaeoecological data about the Lower-Middle Palaeolithic environment had already been overlooked.

The A14 Huntingdon to Cambridge improvement scheme involved 250 archaeologists working on 40 sites, 70% of whom were drawn from the European mainland (www.highways.gov.uk/A14C2H). More than 40 major infrastructure projects are planned across the UK in the period 2015-33, the majority falling between 2015 and 2020. Historic environment specialist input will be needed in the first few years of these projects, peaking during 2016-20. Although the basis for their figures has been challenged (Rocks-Macqueen 2018), Hook *et al.* (2016) predict a 25%-64% increase in demand for such specialists. This means shortages in suitably skilled staff, especially field archaeologists, archaeological specialists and project/contract managers are likely, particularly after Britain's exit from the European Union reduces its access to continental European archaeologists. In the face of this scenario, the situation with regard to archaeological investigation as part of major infrastructure projects, already unsatisfactory in respect of Lower-Middle Palaeolithic archaeology, can only deteriorate.

Implications

There has to date been no audit of how successfully Lower-Middle Palaeolithic archaeology has been dealt with through the local planning process, although a prime example of the weakness of a system dependent on inadequate local authority monitoring resources can be seen in one of my core study areas. The Caddington Cottages site is one of the very few sites in England where primary context Lower-Middle Palaeolithic archaeology has been found. A planning application for the erection of a new garden centre and parking area for Luton airport on top of the Cottages site was submitted by Eden Brae Business Park (Central Bedfordshire 2017). There was no reference at any point in the documentation accompanying this application, nor in any of the officers' reports, to an archaeological assessment or to the potential archaeological significance of the site. Nor was there any indication that the Bedfordshire HER had been consulted, since the Cottages sites is noted therein as 'Main

Caddington locality as investigated by W.G. Smith from 1889 where he found his 'palaeolithic floor' i.e. material in primary context some of which could be refitted' (Bedfordshire HER 605). Other Worthington Smith sites in the area are noted in the HER simply as 'discoveries made by W.G. Smith', even though primary context archaeology was present in at least one. Both the initial application and subsequent planning appeal were refused, but only on the grounds that the proposed airport parking area would be an unacceptable intrusion into the Green Belt. This, despite the fact that Historic England planning guidance (Historic England 2016) states that the archaeological interest of an asset can remain even after apparently thorough investigation, as techniques and understanding of the past improve. If this is the fate of a Lower-Middle Palaeolithic site which has been extensively published (Dyer 1978; Roe 2009; Sampson 1978; Scott-Jackson 2000; Smith 1894, 1916; Wessex Archaeology 1996; White 1997; White *et al*. 1999) and is generally acknowledged as being of national significance, the same must be happening on a large scale to less well-known sites across the country.

Unlike many European countries, the UK has never translated the 1992 European Convention on the Protection of the Archaeological Heritage (the Valetta Convention) into statute - only into national policy and practice. This means there is no statutory safety net for England's archaeological heritage should that policy and practice be changed (Trow 2016). English archaeology, already vulnerable at both local and national level, is seriously threatened by further Government deregulation and reduced local authority control over local planning decisions. In this circumstance the Lower-Middle Palaeolithic archaeological resource is particularly vulnerable not only because of the usually ephemeral nature of its remains but also because few field archaeologists, local authority archaeological advisers or PAS staff have an in-depth understanding of the early Palaeolithic.

iii) France

Legislative background and administrative arrangements

French Government archaeological policy and strategy is very different from that in England and has also undergone dramatic changes in the past 30 years (Depaepe and Salas-Rossenbach 2013). France's ratification of the Valletta Convention in 1996 was followed by the Heritage Law of 2001

(law no. 44 of 17 January) and its amendment in 2003 (law no. 707 of 1 August). Further legislation in 2016 saw archaeological finds become the property of the State and, in common with many other European countries, France now considers archaeological ground to be national property (Demoule 2016; Depaepe 2016). In England it is the property of the surface owner of the land.

At a national level, responsibility for the management of the French archaeological heritage lies with the Ministère de la Culture (Ministry of Culture). The Ministry's Division of Archaeology is responsible for national policy development, regulation and monitoring of the implementation of heritage legislation. It must also ensure the application of heritage protection measures in the context of land-use planning, as well as developing and participating in state-led scientific and technical monitoring during archaeological research operations. This contrasts sharply with England, where Government Departments make policy but all monitoring and implementation responsibilities lie with the local authorities. Several locally-based Regional Archaeological Services (SRAs), together covering the whole of France, sit within the Ministry of Culture's Regional Directorate for Cultural Matters (DRAC). The SRAs within DRAC are in charge of implementing state policy in respect of heritage protection, conservation and promotion, including delivering excavation permits, prescribing diagnostics and preventive excavations and monitoring and controlling operations. They have the authority to reject any developer-selected competitive tenders in which they consider the archaeological resources quoted are inadequate to meet the legislative requirements (M. Cortiller *pers. comm.* 12th April 2016). The SRAs are also responsible for the scientific exploitation of the archaeological evidence revealed in excavation reports and for deciding the fate of any archaeological finds, which may be shared between the state and the landowner.

Eight inter-regional archaeology commissions, each chaired by a representative of the State, ensure coverage of the whole of mainland France and its overseas territories, including marine archaeology. The whole system is financed by a tax on every development project (5300 euros per hectare in 2016) even if there is no archaeological evaluation. The tax pays for the evaluation and a third of it subsidizes poorer

developers - e.g. social housing construction or private houses (Hulin *et al.* 2018). The amount allocated for the whole development depends on the area of the project and the complexity of the evaluation (defined by ministerial decree). In this way, archaeology is seen as a public service which must be adequately funded rather than, as in England, an unfortunate distraction to the important business of building development, to be dealt with at the lowest possible cost to the commercial developer.

Archaeological resources at the local and national level

The Ministry of Culture maintains a map of French archaeological resources, the *Reseau Nationale des Lithotèques* (Turq *et al.* 2017). However, it is French Government policy not to publish the map co-ordinates for archaeological sites, to protect them from potential looters (E. Goval *pers comm.* 10th April 2016). This contrasts sharply with the routine publication of Ordnance Survey co-ordinates in British archaeology reports, books and journal articles.

Some 345 state archaeologists are employed by the Ministry of Culture (Depaepe and Salas-Rossenbach 2013). In addition, a number of local authorities (cities, counties *etc.*) have their own archaeological services, together employing ~700 archaeologists. Dwarfing all is the number of archaeologists employed by INRAP (Institut National de Recherches Archéologiques) a public research institution under the joint aegis of the Ministry of Culture and the Ministry of Higher Education and Research. Created in 2002 under the 2001 Heritage Act, INRAP is responsible for detecting and studying heritage sites threatened by infrastructure and development works, for co-ordinating and disseminating information to the scientific community and promoting archaeological heritage through public outreach and education. With a global budget of ~170M euros a year and 44 archaeological research centres throughout the country, INRAP employs a wide range of specialists, including archaeologists, geologists, palynologists, sedimentologists, zooarchaeologists and dating experts. It is responsible for almost 70% of archaeological works carried out in French territory (Catteddu *et al.* 2012). In Britain private contractors now employ some 59% of archaeologists (Hook *et al.*2016) but in 2014 there were only 19 accredited private operators in France, between them employing only ~300 archaeologists (Depaepe and Salas-Rossenbach 2013). INRAP's

dominance of archaeological fieldwork and its in-house resource of Pleistocene specialists means that Lower-Middle Palaeolithic archaeology is much less threatened that is the case in the UK, with sites far more likely to be properly identified and dealt with.

The 2003 revision of the French heritage laws aimed to reduce costs for developers and minimise delays (Depaepe and Salas-Rossenbach 2013). While reaffirming the legitimacy of preventive archaeology and the remit of INRAP, it clearly distinguished between diagnostic archaeology on the one hand and excavation on the other. Although diagnostic archaeology remains under the control of the state (INRAP), excavation could now be carried out by competent operators previously approved by the state, whether public or private. This opened the door to commercial archaeological contractors and removed INRAP's monopoly on excavation (Catteddu *et al.* 2012). As in England, the developer could henceforth choose the operator of his choice, agreeing a price from case to case, with potential implications for the archaeology. During construction of the A29 East and West, for example, sondages were taken about every 50 metres but only to the depth permitted by the budget provided by the construction company (Locht *et al.* 2010.

Deadlines for carrying out archaeological investigations are tightly proscribed by law and developers can call on the state to force a contracting unit to accept deadlines, sometimes to the detriment of the quality of archaeological intervention (Depaepe and Salas-Rossenbach 2013). SRAs have been subject to significant cuts since the financial crisis of 2008, making it difficult for them to fulfil their dual mission of ordering archaeological investigation before the destruction of a site and maintaining control over scientific standards (Demoule 2016). As in England, archaeology is now subject to market fluctuations and the resulting severe competition between archaeology units fighting to secure contracts from developers looking only for the best price can lead to lower scientific standards. Since the economic crisis of 2008, commercial companies have reduced their prices >40% on average (Demoule 2016).

Preventive archaeology may have been defined as archaeological research specific to the detection and study of threatened archaeological remains (Depaepe and Salas-Rossenbach 2013) but it has also been described

(Novaković 2016) as a field of conflict of interests, negotiations and debate between the various stakeholders, including archaeologists. An estimated 90% of archaeological excavations in Europe fall within the framework of preventive archaeology (Demoule 2016) and it is now completely accepted as an integral part of the whole process of the preservation and study of cultural heritage in France (Depaepe and Salas-Rossenbach 2013). However, about 700km^2 of land in France is affected each year by private and public house-building, the construction of commercial and industrial zones, quarries, roads and railways, with the discovery of an important site about every 800m. For practical and scientific reasons, not all can become the subject of preventive archaeology and the selection of such sites rests with the French state (Catteddu *et al.* 2012*).*

Major infrastructure projects

The scale of French archaeological investigation along major infrastructure projects dwarfs that carried out in Britain. In Picardie (the control area for my research) a large linear project is implemented every four years. In 1989 it was the TGV Nord high-speed railway line; between 1991 and 1993 the A16 Nord autoroute between Amiens and Abbeville; in 1996 the A16 South between Amiens and Beauvais; in 1998 the A29 East between Amiens and Saint-Quentin and in 2002 the A29 West between Amiens and Aumale (Goval and Coutard 2016). These were followed between 2008 and 2014 by the preliminary works for the first phase of the Canal Seine-Nord Europe between Aubencheul-au-Bac and Compiègne.

Both France and Germany systematically carry out machine trenching on about 10% of the surface area of major development works prior to construction. While developers may prefer the more limited methods used in the UK, the number of sites discovered in France as a result of large-scale surface stripping is five times greater (Demoule 2016). Only such large-scale surface stripping and excavation enables the study of scattered settlement patterns and human mobility in the landscape (Catteddu *et al.* 2012), making it particularly effective in identifying Lower-Middle Palaeolithic archaeology.

The primary diagnostic method used for all preventive archaeology in rural areas of France consists of long, machine-dug trenches, 20m apart on average, extended by complete surface stripping when archaeological

remains are located and complemented by spot surveys in depth, allowing the detection of archaeological remains at 30-50cm depth (Locht *et al.* 2010). This methodology allowed the testing of 10% of the entire surface of the Canal Seine-Nord Europe and its associated works (Prilaux and Talon 2012). Although rare in the UK, the number and range of archaeological sites identified as a result of large-scale surface stripping on the A14 improvement scheme indicates the scale of what is potentially being missed in England because of the more limited archaeological investigations usually carried out.

The use of sondages to locate sites in areas of promising geomorphology is one of the distinctive features of preventive archaeology in northern France, requiring knowledge of the geomorphology and prehistory of a region. This approach, which with its emphasis on geomorphology again benefits the Lower-Middle Palaeolithic resource, is crucial as French archaeological law now permits the subsequent excavation of only primary context sites (Locht *et al.* 2010). In 1994, for example, 54 sondages along the line of the A16 Nord identified 2 sites, of which only 1, Betterncourt-Saint-Ouentin, was excavated. In 1998, 204 sondages along a 63km stretch identified 8 sites of which only Gentelles was subsequently excavated fully.

In urban areas, however, sondages on building projects are possible only in intended open spaces. For practical reasons, they are never located underneath future dwellings, except in the case of underground parking. Features such as sceptic tanks, cess pits and drainage trenches – which might go deep enough to disturb well-preserved Lower-Middle Palaeolithic archaeological layers - rarely appear on development plans so are never investigated (Locht *et al.* 2010).

Construction of the Canal Seine-Nord Europe provided INRAP with an opportunity to explore large areas in Nord Pas-de-Calais and Picardie, especially in the Somme and Oise départements. The dimensions of this project are exceptional, the canal being on average twice as wide as a motorway and with earthworks reaching depths of 45m (Hulin *et al.* 208). In total, the canal works involved the archaeological investigation of 2,500 ha. of land (6177 acres) to the requirements set down by the SRA and the excavation of a total of 882 deep sondages, taken down to bedrock wherever possible. Five sectors of the Canal, around Havrincourt, Etricourt-

Manancourt, Languevoisin-Quiquery, Catigny and Noyon, were identified as being favourable for the preservation of Palaeolithic archaeology (Hérisson and Goval 2013) and by 2012 700 hectares (1729 acres) had been assessed and 320 sites identified, including 26 Palaeolithic sites (Talon 2012). Three large-scale excavations of Lower-Middle Palaeolithic sites were subsequently completed, at Etricourt-Manancourt and Havrincourt (Goval and Coutard 2016; Hérisson and Goval 2013).

At Etricourt-Manancourt, (Somme), an area of more than 4,500m^2 was excavated to an average depth of 6 metres, equating to the exploration of almost 3000m^3 of sediment (Hérisson *et al.* 2016). At Havrincourt (Pas-de-Calais) the discovery of several levels of Palaeolithic flint artefacts embedded in a relatively thick (~6-7m) loess sequence led to a 6000m^2 excavation (Guérin *et al*. 2017). In both cases, detailed pedosedimentary and interdisciplinary geochronological survey was carried out, facilitated by INRAP's wide range of in-house specialists.

Between Noyon (Oise) and Aubencheul-au-Bac (Nord) the Canal runs along the Chalk plateau, offering an unprecedented opportunity for the systematic excavation of plateau loess deposits over a distance of nearly 80km (Prilaux and Talon 2012). Here, sondages were dug to a depth of 13 to 14 metres (14.22 to15.33 yds) using a mechanical digger with an arm extension. Once deposits potentially containing archaeological levels were observed, the contents of the digger bucket were emptied manually to look for lithic or faunal remains. In the event of a positive result a stepped trench was dug to allow archaeologists direct access to the archaeological levels to assess their potential, with subsequent widening of the trench if necessary.

Implications

France's ratification of the Valetta Convention provides a statutory 'safety net' for French archaeology and because the French State has significantly more control over and invests substantially more resources in protecting the archaeological heritage than the British Government, Lower-Middle Palaeolithic archaeology in France is at significantly less risk of loss. The large-scale surface stripping carried out for major French infrastructure projects, coupled with the expertise of INRAP's multi-disciplinary teams and the protective qualities of thick loess deposits, has resulted in the

identification and subsequent excavation of multiple *in situ* Lower-Middle Palaeolithic sites on the French Chalklands.

iv) Discussion

In this chapter I have compared the heritage management strategies of the English and French states and identified a number of substantial differences between them, with significant implications for the management and protection of the Lower-Middle Palaeolithic archaeological resource:

i) The French Government is responsible for national policy development and also for regulating and monitoring the implementation of that policy. The British Government is responsible only for national policy development. Regulation and monitoring falls to local authorities under their planning responsibilities;

ii) Only one directly relevant French Government department, the Ministry of Culture, is involved with managing the archaeological heritage. In Britain, two Government departments are involved – the DCMS sets heritage policy but the Ministry of Housing, Communities and Local Government is responsible for planning policy and implementation;

iii) The French Ministry of Culture employs ~345 archaeologists in regionally based archaeological services (SRAs) responsible for implementing state policy. It also funds 44 INRAP archaeological research centres responsible for detecting and studying threatened heritage sites, disseminating information and promoting archaeological heritage. Neither the DCMS nor the Department of Housing employs any archaeologists, the DCMS instead relying for archaeological advice on Historic England, an executive non-departmental public body with no direct access to politicians.

iv) The French Government levies a tax on every development project, even where no archaeological evaluation is required. This is allocated back to development projects for archaeological evaluation in amounts decreed by the Ministry. In Britain, although local authority archaeologists may write the initial brief, developers produce their own Schemes of

Investigation driven by commercial, rather than archaeological considerations. Enforcement of the proper implementation of those Schemes lies with the local authority planning department, not with its archaeologists, who in many smaller local planning authorities – such as North Hertfordshire District Council – are based not in the local planning authority itself but remotely in the County Council Headquarters and may not always be informed of the application by the local planning officer.

v) All French commercial archaeology contractors must have official approval before they may operate and the SRAs also have the authority to reject developer-selected competitive tenders considered to be inadequately resourced archaeologically. There is no such provision in Britain.

Despite some reduction in the resources dedicated to heritage management, the proactive approach of French Government policy and strategies contrasts sharply with that in Britain. The resultant significant implications for the creation and preservation of their respective Lower-Middle Palaeolithic archaeological records, analysed in detail in Chapter Nine, are compounded by their different geomorphologies.

Thick loess cover means French archaeology is deeply buried and can be released into the archaeological record only as a result of direct human intervention. Consequently, there were few antiquarian collectors on the French Chalk lands and virtually no surface/chance finds. In total, 65.8% (1166) of the 1772 British entries in my Chalklands Lower-Middle Palaeolithic dataset were recorded as surface/chance finds or have no recorded provenance. For France, the figure is only 17.4%.

State ordered archaeological fieldwork conducted by professional archaeologists was responsible for 59.3% of my French dataset entries. In England, the fieldwork figure is only 7.9%, more than a third of it conducted by amateurs. Adequately resourced French Government control of archaeological work at a local level means that even small-scale infrastructure construction and domestic building is properly monitored and only archaeologically satisfactory contracts are allowed to proceed.

The cumulative result is that the distribution patterns visible in the British and French Lower-Middle Palaeolithic archaeological records for the Chalk uplands look very different. The French record is made up primarily of archaeological ‘patches’ (Isaac 1989). That of southeast England consists largely of ‘scatters’ and is, for that reason, routinely excluded from interpretations of early human landscape use.

Chapter Nine. The whole landscape matters: identifying the bias in the Lower-Middle Palaeolithic archaeological record of the Chalklands.

i) Introduction

In this thesis I have attempted to isolate the most significant of the variables underpinning the Lower-Middle Palaeolithic archaeological record of the Chalk lands of southeast Britain and northern France and to assess their impact on the distribution patterns visible in that record. Spatial distribution patterns in the archaeological record are frequently used as the basis for interpretations of early human landscape preference. Too often, however, those distribution patterns are taken at face value, with little or no consideration of any potential bias introduced into the archaeological record as a result of variables in the process of its creation. Gaps are interpreted as places visited rarely if at all while, conversely, concentrations of findspots are seen as indicating favoured locations. This means that some parts of the landscape play little part in the formulation of current interpretations, resulting in a restricted and potentially distorted picture of the world inhabited by Lower-Middle Palaeolithic people. To understand that world fully we must identify better ways of interpreting the archaeological data than simply studying findspot distribution maps. I do not have a finished methodology for doing this, but I have developed a robust way of visualising the data.

The variables I selected for analysis were geomorphology, late 19th/early 20th century industrialisation, antiquarian collecting and differences between British and French archaeological policies and research strategies. Complex and cross-disciplinary, not all these variables are easily reducible to quantitative data.

a) *Visualising the relationship between % Clay-with-flints survival and findspot density* (The variable in this instance was geomorphology). The first opportunity for the preservation and subsequent release of artefacts into the Lower-Middle Palaeolithic archaeological record comes with geological context and the geomorphological changes that have occurred in a landscape. The primary aim of my research was to establish the impact of geomorphological processes on the creation of the Lower-Middle Palaeolithic archaeological record and the findspot distribution patterns visible in that record In particular, based on my working hypothesis that

Clay-with-flints can be treated as a proxy for the degree of erosion suffered by the Chalk uplands, I wanted to identify any relationship between findspot density/ distribution patterns and the extent of survival of Clay-with-flints superficial deposits. I also wanted to test the UPLA prediction that geomorphology has had a greater effect on findspot distribution patterns than any other factor.

b) *Visualising the relationship between late 19th/early 20th century industrialisation processes and findspot density.* The variables in this instance were aggregates and brickearth extraction, railway construction, urbanisation and infrastructure development. All involved the exposure, to a greater or lesser extent, of artefact-bearing Middle Pleistocene deposits, offering the second opportunity for the release of artefacts into the archaeological record.

c) *Visualising the relationship between antiquarian collecting activities and findspot density.* The variables in this instance were the number of collectors and the scale and focus of their activities. With 85% of British Lower-Middle Palaeolithic finds locations being the result of antiquarian collecting, they provided the third opportunity for artefacts to enter the archaeological record.

d) *Visualising the relationship between Government policies and research strategies and the shape of the archaeological record.* The variables here were geomorphology and the differences between British and French Government policies and research strategies.

Fig. 9.16 illustrates the sequence of opportunities through which artefacts have entered the British archaeological record.

To better visualise my data I treated each separate land block on the Chilterns, North and South Downs as a separate unit for analytical purposes and considered the impact of each variable on their individual archaeological records. First, I created geological maps for my core study areas using ArcGIS and calculated the areas of Chalk and surviving Clay-with-flints on each interfluve in km^2. I then compiled a database of 1772 British and 167 French archaeological findspots and plotted them against the maps to identify the geological context of each. Next, I counted the number of finds on Chalk and Clay-with-flints on each interfluve and used Excel to calculate their findspot density in 100km^2 (38.6mi^2). I then

analysed the circumstances of discovery of each findspot (antiquarian collecting, modern excavation/fieldwalking or industrialisation) to establish the scale of their contribution to the archaeological records of the individual interfluves. Finally, I considered the differences between British and French geomorphology, official policies and strategies and their effect on the archaeological records of the two countries.

Visualising the data in this way enabled me to establish the impact of all four variables on the formation of the archaeological record and, consequently, on distribution patterns within that record. In this chapter, I present my results for each variable in turn. As explained in Chapter Six, I use three separate terms to describe my data entries. I use 'Findspot' for a site actually mapped onto my ArcGIS generated geology maps. These may be single entries or multiple entries which have an individual HER, PAS or SRPP/TERPP but share a single NGR, so generate a single mark on the geological maps. 'Dataset entries' is the term I use for both of the above categories of data when counting the number of entries in my site lists without reference back to the geological mapping. Both findspots and dataset entries are used only for entries situated on the Chalk bedrock footprint of each interfluve, calculated in 100km^2 (38.6 mi^2). 'Total dataset entries' is used when I am including all the entries in my Chalklands Lower-Middle Palaeolithic dataset, regardless of the bedrock on which they sit.

ii) Visualising the relationship between geomorphology and findspot distribution.

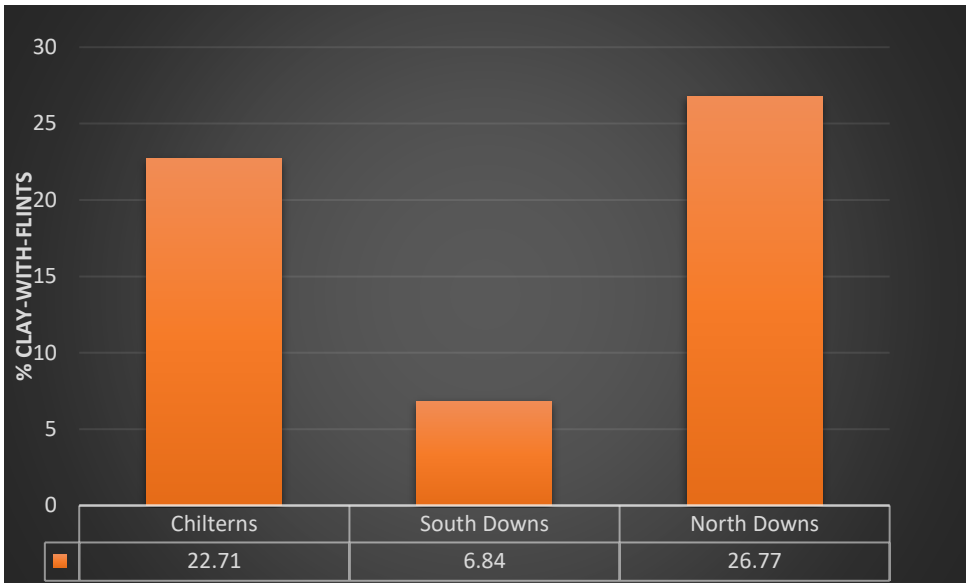
In this section I analyse the relationship between findspot density and surviving percentage of Clay-with-flints on each interfluve. I also analyse the number of findspots in relation to the erosional edges of that Clay-with-flints and the number on Head deposits on the valley slopes and bottoms.

% Clay-with-flints survival

The northern limit of surviving Clay-with-flints on the Chalk uplands is on the Chilterns between Luton and Welwyn, coinciding approximately with the inferred ice margin of the MIS12 glaciation (Catt 1986). A residual surface deposit, Clay-with-flints is known to have produced numerous artefacts, thanks to its ability to initially preserve and then subsequently release them into the archaeological record as it erodes away. I explained the reasons for this ability in Chapter Five.

The amount of surviving Clay-with-flints as a percentage of each Chalk interfluve varies significantly between my three core study areas (Fig. 9.1), with the highest percentage on the North Downs and the lowest on the South Downs.

Fig. 9.1 Comparative % surviving Clay-with flints in each core study area.



This figure illustrates the enormous difference in total percentages of surviving Clay-with-flints between the South Downs, where Clay-with-flints is sparse and fragmented and the North Downs and Chilterns, each with individual interfluves with dense Clay-with-flints survival (see Table 9.1 below).

There are also substantial differences in the amount of surviving Clay-with-flints on each individual interfluve (Table 9.1). Table 9.2 details the number of findspots on Clay-with-flints and Chalk on each interfluve and calculates the density per 100km^2 (38.6mi^2) of each.

My working hypothesis predicted that if geomorphology, not human behaviour, has been the prime control over recorded artefact density, then the relative abundance of upland findspots should increase and decrease proportionally to Clay-with-flints survival. Where there is little surviving Clay-with-flints finds will mostly have eroded away. Where there is dense Clay-with-flints finds will be obscured by the geology and between these extremes there will be optimal conditions for erosional artefact release and recovery. If that hypothesis is correct then the results of my analysis should resemble the sine curve in Fig. 9.2 below. If the relationship between Clay-with-flints survival and findspot density is linear, with increasing findspot density increasing as surviving Clay-with-flints increases, then the results should resemble Fig. 9.3. If there is no relationship between

Table 9.1 Percentage surviving Clay-with-flints on each interfluve

Location	Chalk 100km^2	C-w-F 100km^2	% C-w-F
South Downs			
Eastbourne - Cuckmere	0.66	0.07	10.61
Cuckmere - Ouse	0.80	0.04	5.00
Ouse - Adur	1.43	0.06	4.20
Adur - Arun	0.76	0.07	9.21
Arun - Lavant	3.74	0.02	0.53
Lavant - Ems	1.21	0.04	3.31
Ems - Meon	2.22	0.17	7.66
Meon - Itchen	1.74	0.29	16.67
Itchen-Test	2.20	0.25	11.36
Totals	***14.76***	***1.01***	***6.84%***
Chilterns			
Hitchin – Lilley Bottom.	1.67	0.19	11.38
Lilley Bottom - Luton	1.74	0.42	24.14
Luton - Dunstable	1.70	0.43	25.29
Dunstable - Dagnall	1.99	0.58	29.15
Dagnall-Tring	1.23	0.27	21.95
Tring – Wendover	3.12	0.98	31.41
Wendover – Princes Risboro'	2.03	0.60	29.56
Princes Risboro' – Goring	5.72	0.89	15.56
Totals	***19.20***	***4.36***	***22.71%***
North Downs			
Folkestone – Great Stour	5.21	1.12	21.49
Great Stour-Medway	3.82	1.48	38.74
Medway - Darent	2.77	0.54	19.49
Darent - Merstham	1.92	0.77	32.81
Merstham - Mole	1.71	0.48	28.07
Mole-Wey	0.66	0.09	13.64
Wey – Blackwater- Loddon	0.12	0.0002	0.17
Totals	***16.21***	***4.34***	***26.77%***

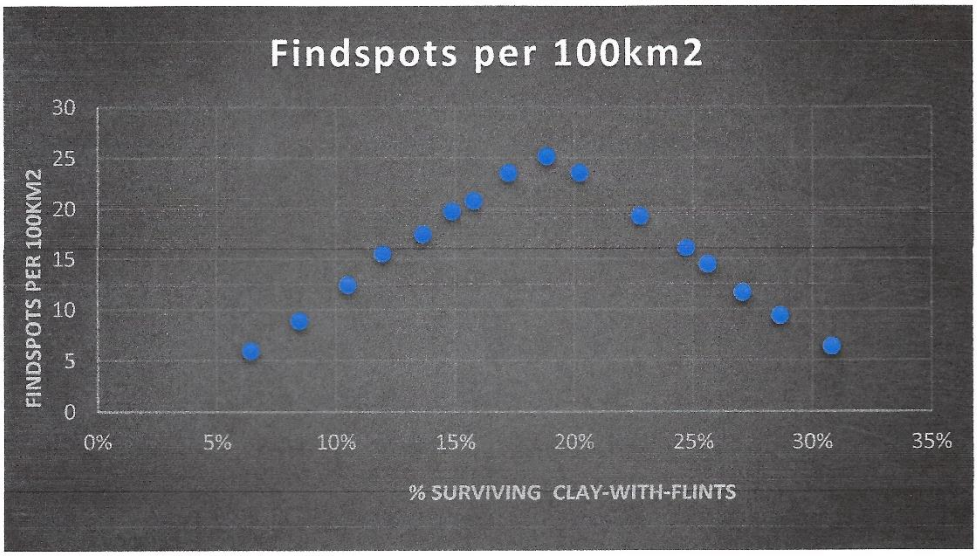
Clay-with-flints survival and findspot density then the resulting distribution pattern should be random, as illustrated in Fig. 9.4. Fig. 9.5 shows the results of an initial analysis of all three of my core study areas.

As can be seen in Fig. 9.5, there is clearly some relationship between findspot density and Clay-with-flints survival, as finds density in each area rises as Clay-with-flints increases, up to a point at which it begins to decline while surviving percentages of Clay-with-flints continue to increase. This is in line with my working hypothesis' prediction that artefacts will cease to be released into the archaeological record once surviving Clay-with-flints deposits become too thick.

Table 9.2. Findspot density on the Clay-with-flints and Chalk of each interfluve, calculated per 100km^2 of Chalk.

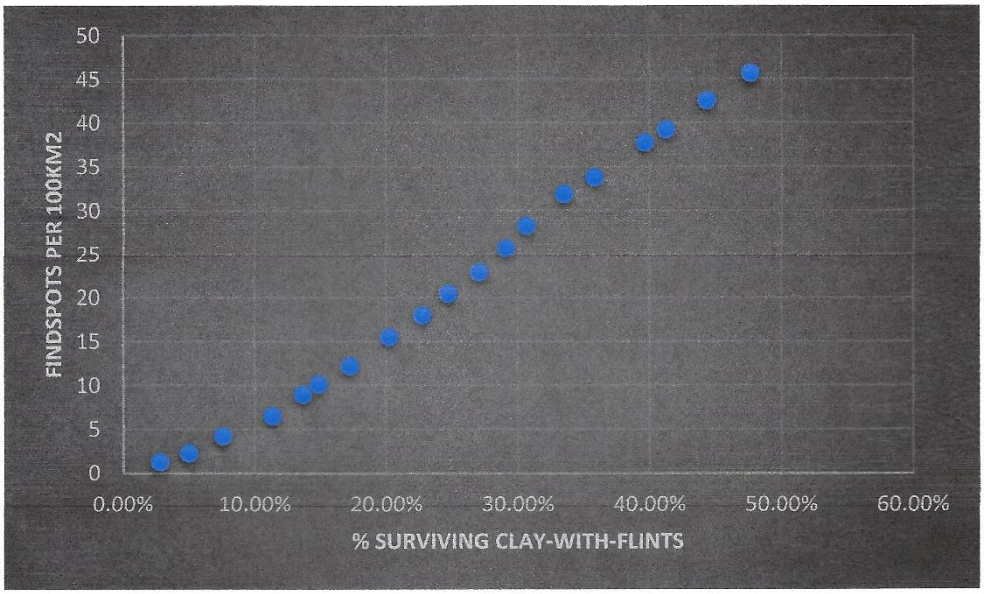
Location	Chalk 100km^2	Find spots on C-w-F	Find spots per C-w-F 100km^2	Total Find spots on Chalk + C-w-F	Total Find spots per 100km^2
South Downs					
Eastbourne - Cuckmere	0.66	1	14	15	22.73
Cuckmere - Ouse	0.80	2	50	5	6.25
Ouse - Adur	1.43	1	17	9	6.29
Adur - Arun	0.76	1	14	6	7.89
Arun - Lavant	3.74	2	100	5	1.34
Lavant - Ems	1.21	0	0.00	2	1.65
Ems - Meon	2.22	3	18	9	4.05
Meon - Itchen	1.74	0	0.00	4	2.30
Itchen-Test	2.20	2	8	12	5.45
Totals	***14.76***				***57.95***
Chilterns					
Hitchin – Lilley Bottom.	1.67	2	10.53	6	3.59
Lilley Bottom – Luton	1.74	5	11.90	9	5.17
Luton - Dunstable	1.70	14	32.58	23	13.53
Dunstable-Dagnall	1.99	6	10.34	10	5.03
Dagnall – Tring	1.23	0	0.00	0	0.00
Tring-Wendover	3.12	5	5.10	16	5.13
Wendover-Princes Risboro'	2.03	1	1.67	9	4.43
Princes Risboro'-Goring	5.72	4	4.49	34	5.94
Totals	***19.20***				***42.82***
North Downs					
Folkestone – Great Stour	5.21	19	16.96	33	6.72
Great Stour-Medway	3.82	5	3.38	16	4.19
Medway - Darent	2.77	23	42.59	66	23.83
Darent - Merstham	1.92	11	14.29	42	21.88
Merstham - Mole	1.71	19	39.58	29	16.96
Mole-Wey	0.66	0	0.00	0	0.00
Wey – Blackwater-Loddon	0.12	0	0.00	0	0.00
Totals	***16.21***				***73.19***

Fig. 9.2. Relationship between Clay-with-flints survival and findspot density predicted by my working hypothesis.



This figure illustrates the distribution graph predicted if there is a non-linear relationship between Clay-with-flints survival and findspot density.

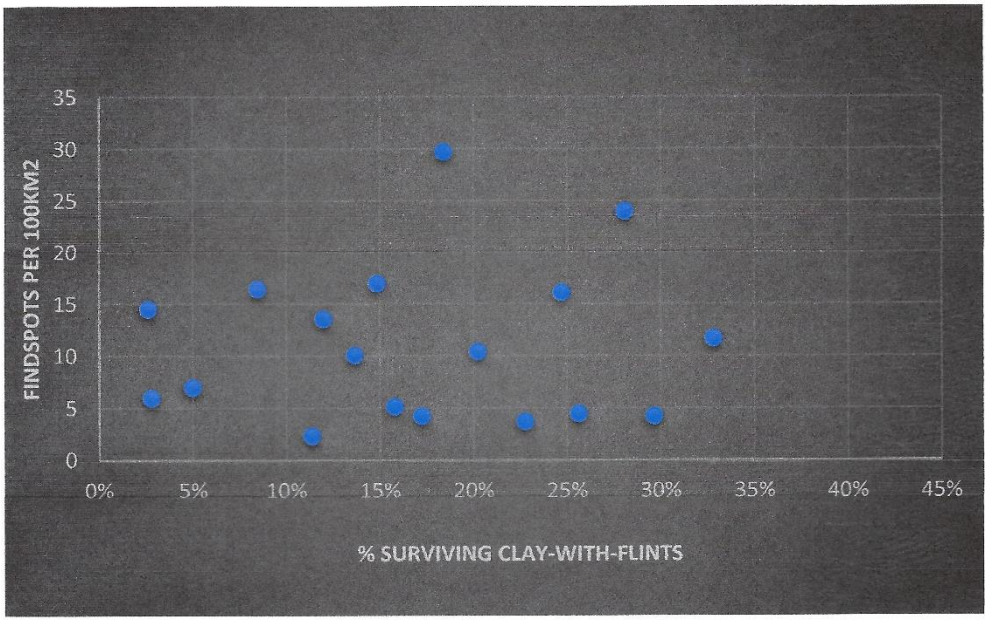
Fig. 9.3. A linear relationship between findspot density and Clay-with-flints survival.



This figure illustrates the distribution graph predicted if Clay-with-flints survival and findspot density increase together in a linear relationship.

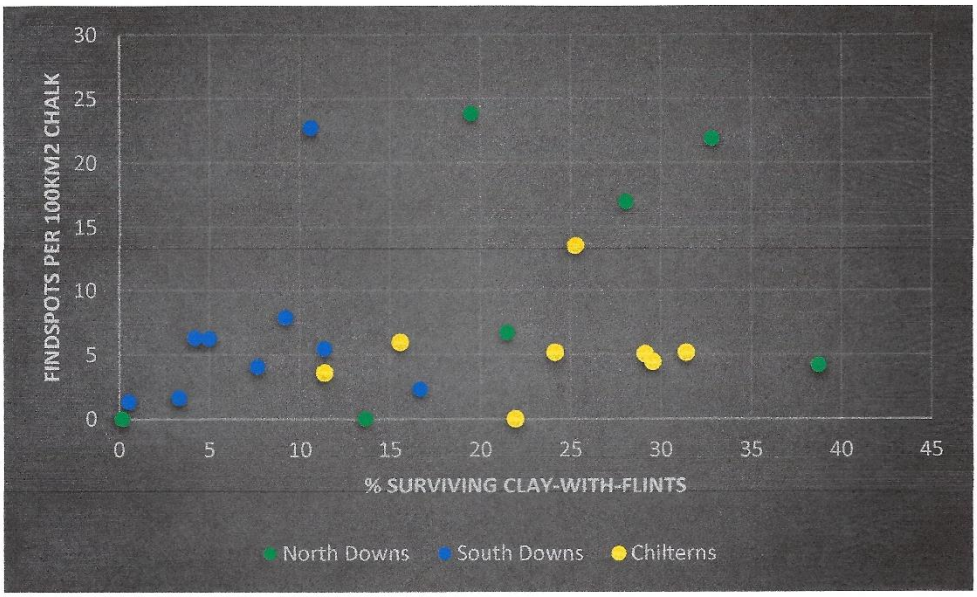
However, because the study areas do not overlap fully in terms of Clay-with-flints survival there is not one curve but what appear to be three separate, although in the case of the Chilterns and North Downs overlapping, curves (Fig. 9.5). The significant differences in degree of Clay-with-flints survival between the areas alters the exact point at which the change takes place, but the pattern of behaviour is the same.

Fig. 9.4. No relationship between Clay-with-flints survival and findspot density.



This figure illustrates the random distribution pattern predicted if the relationship between Clay-with-flints survival and findspot density is non-existent.

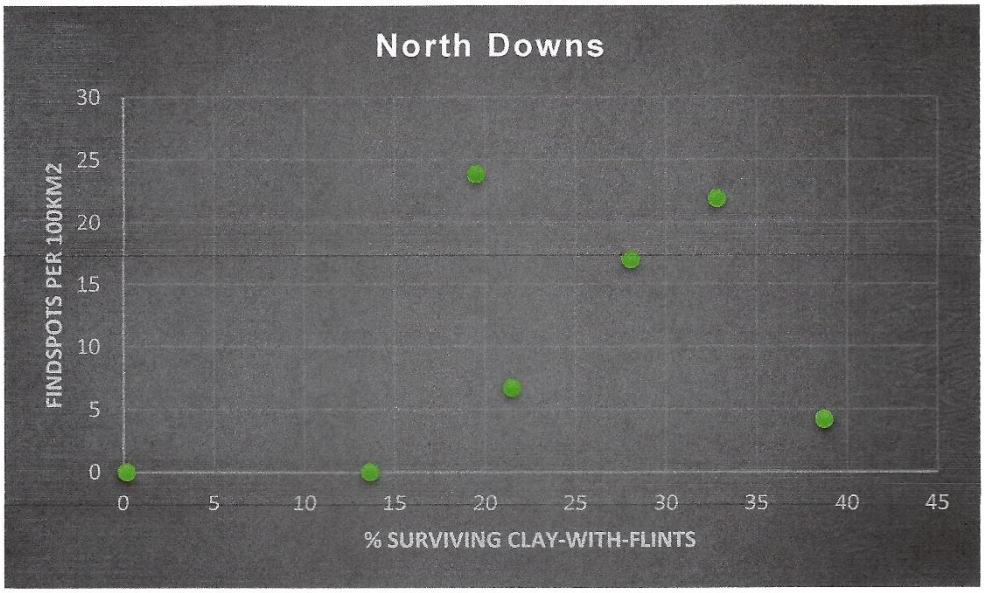
Fig. 9.5. Comparative analysis of findspot density and Clay-with-flints survival in all three of my core study areas.



This figure illustrates the distribution patterns resulting from a comparative analysis of my three core study areas. It shows three separate curves, one for each area, reflecting the differences in their % Clay-with-flints survival.

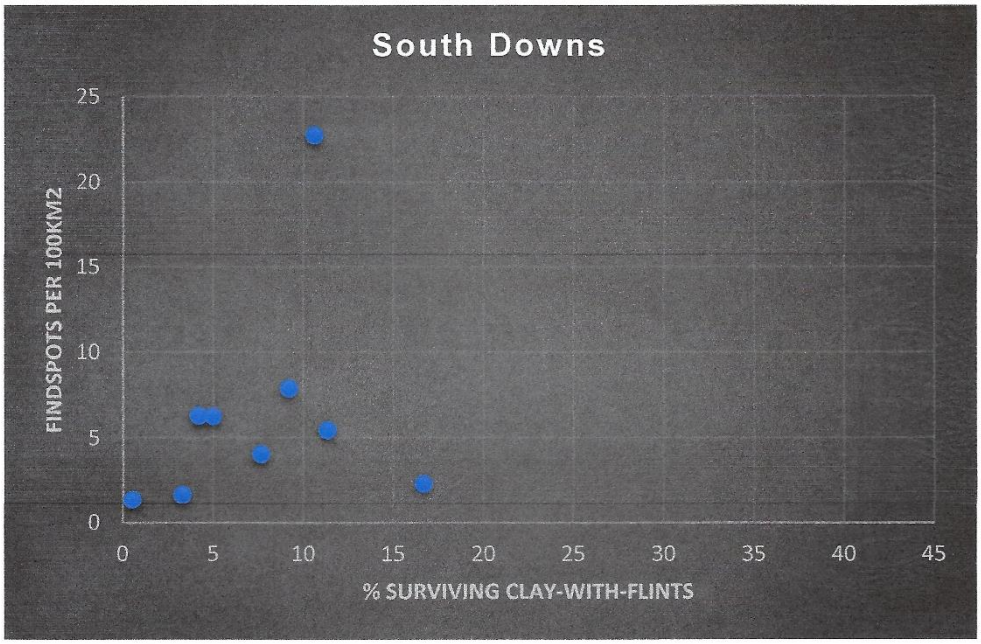
When each area is plotted separately, the picture becomes clearer for the North and South Downs (Figs. 9.6 and 9.7 below). In each case, however,

Fig. 9.6 Relationship between Clay-with-flints survival and findspot density on the North Downs.



This figure shows the predicted relationship of findspot density rising as Clay-with-flints increases, up to a point at which it begins to decline while surviving percentages of Clay-with-flints continue to increase. The 23.83 findspots per 100km^2 at 19.49% Clay-with-flints survival is, however, anomalously high, for reasons explained below.

Fig. 9.7 Relationship between Clay-with-flints survival and findspot density on the South Downs.



Despite the much lower percentages of Clay-with-flints survival, this figure also shows the predicted relationship of findspot density rising as Clay-with-flints increases, up to a point at which it begins to decline while surviving percentages of Clay-with-flints continue to increase. The 22.73 findspots per 100km^2 at 10.61% Clay-with-flints is, however, extraordinarily high, for reasons explored in Chapter Ten.

there is an apparently anomalous outlier. On the North Downs there is an unexpectedly high findspot density at 19.49% surviving Clay-with-flints. On the South Downs there is an even more anomalous high findspot density at

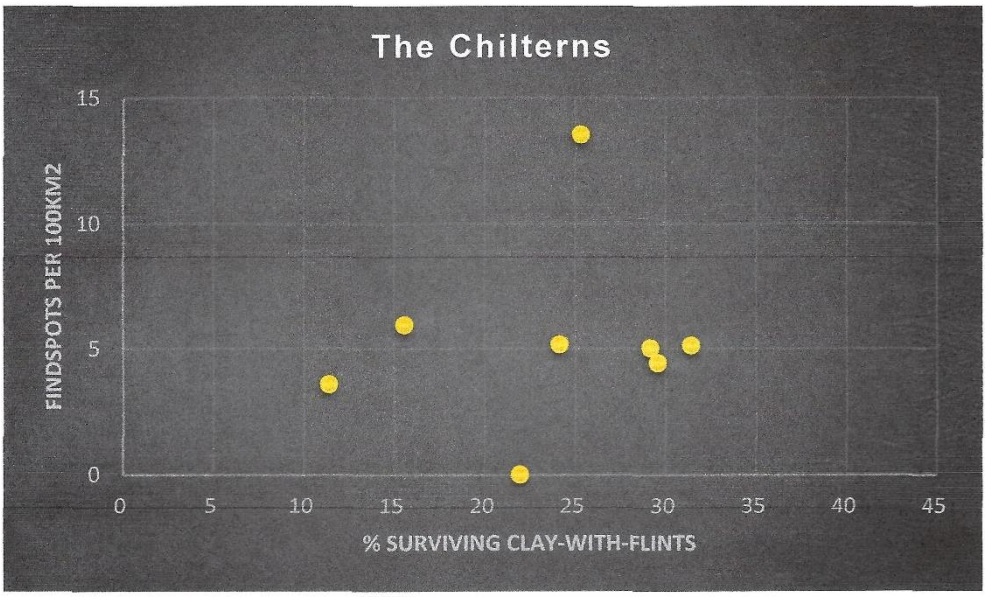
only 10.61 % surviving Clay-with-flints. Possible explanations for these anomalies are explored later.

I carried out a limited comparative study of artefact density and Clay-with-flints survival for the area of the Hampshire Downs around Basingstoke and Alton, based only on data drawn from SRPP/TERPP. This area lies just north of the South Downs and the two areas share similarly fragmented surviving Clay-with-flints yet there are significant differences in the number of findspots recorded from each, with numerous palaeoliths having been found on the surface of the Chalk and Clay-with-flints in the Basingstoke/Alton area. The most prolific site, at Holybourne Down, Froyle, sits on Clay-with-flints on the highest point of this part of Hampshire (Scott-Jackson and Scott-Jackson 2008; Scott-Jackson and Winton 2001).

My analysis showed a findspot density of 16.72 per 100km^2 (38.6mi^2) against a Clay-with-flints survival of 18.09%. This is high by comparison with findspot density on the nearby South Downs, but in the early part of the 20th century the area was scoured by a number of dedicated collectors from the Hampshire Field Club, including G. W. Willis, J.R. Ellaway, H. Rainbow and occasionally O.G.S. Crawford. Founder of the Basingstoke Museum and Field Club local secretary for Basingstoke from 1920 onwards, Willis alone collected over 300 artefacts from Holybourne Down (Taylor 1985; Winton 2004, 115). Other notable members of the Field Club were Leslie Grinsell and William Dale, honorary general secretary for 37 years from 1887 onwards and a major collector of artefacts from the gravels around Southampton. There were no collectors operating on such a large scale on the Chalk of the Sussex Downs.

The picture is less clear cut for the Chilterns (Fig. 9.8 below) although it is possible that an additional geomorphological factor is at work here. Valley orientation changes slightly between the southwestern Chilterns near the Thames and the northeastern Chilterns, suggesting the direction of regional dip swings gradually from SSE near the Thames to ESE in the northeast Chilterns (Catt 2010, 95). This may have contributed to the apparent disruption between the two halves of the Chilterns.

Fig. 9.8 Relationship between Clay-with-flints survival and findspot density on the Chilterns.



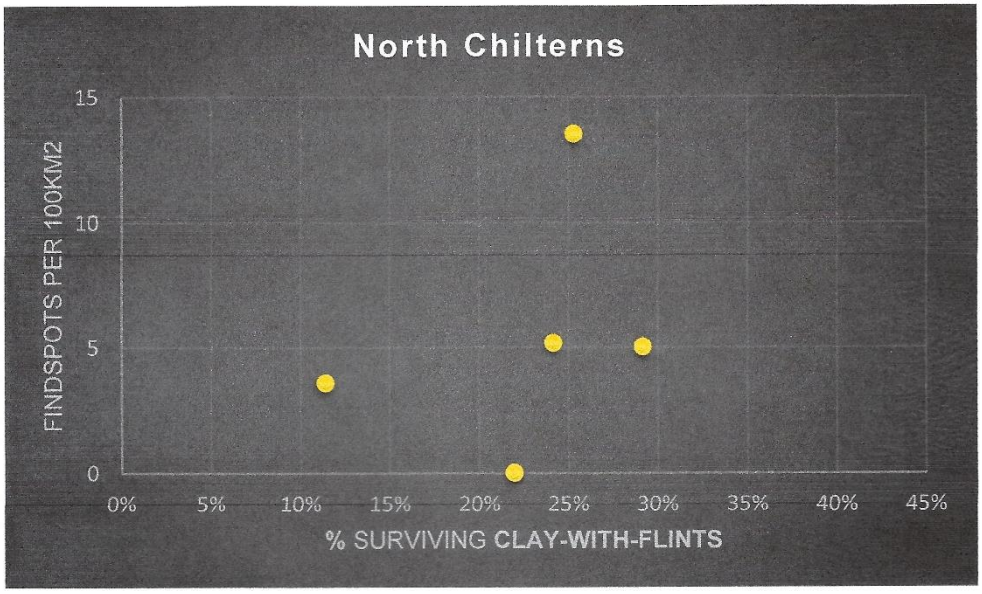
Unlike the North and South Downs, there is no clear relationship between Clay-with-flints survival and findspot density when the north and south Chilterns are plotted together. There are, however, geomorphological differences between the two, both in their valley orientation and distribution of surviving Clay-with-flints which, while still substantial, is more fragmented over larger areas in parts of the South Chilterns.

When the two areas are mapped separately the North Chilterns follows a similar pattern to the North and South Downs (Fig.9.9 below) albeit to a lesser extent. The number of findspots increases with increased Clay-with-flints survival up to a point, in this case at 25.29%, beyond which it falls again. There are two apparent anomalies. The surprising zero findspot density at 21.95% Clay-with-flints survival (between the Tring and Dagnall Gaps) is explicable by the landscape history of this interfluve, from which there are no finds at all identified in my total database. The reasons for this are explained in Chapter Six. The peak of 13.53 findspots at 25.29% Clay-with-flints survival on the Luton-Dunstable interfluve may have been affected by the collecting activities of Worthington Smith, a possibility I explore in section iv) of this chapter.

There is no clear pattern on the South Chilterns, although this may be because with only three interfluves I have only three data points, falling in a narrow range of between 4.43 and 5.94 findspots per 100km^2 (38.6mi^2). There is a fall in findspot density from a high of 5.94 at 15.56% Clay-with-flints survival to 4.43 at 29.56% Clay-with-flints, which is in line with my working hypothesis. This is, however, followed by a contradictory rise in

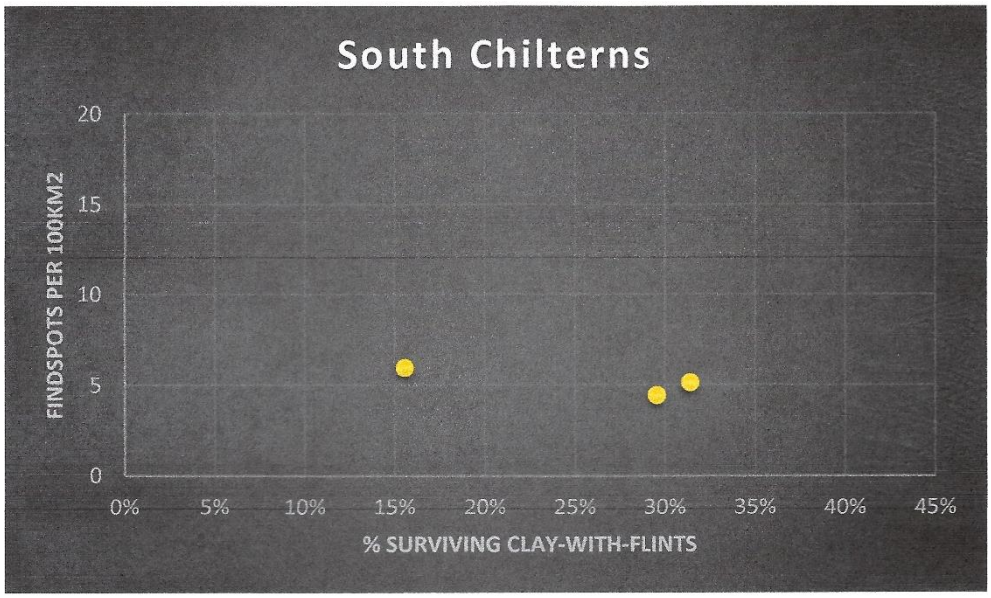
findspot density to 5.13 per 100km^2 at the point at which Clay-with-flints survival increases to 31.41%.

Fig. 9.9 Relationship between Clay-with-flints survival and findspot density on the North Chilterns.



While less clear than on the North and South Downs, this figure does show a relationship of findspot density rising as Clay-with-flints increases, up to a point at which it begins to decline while surviving percentages of Clay-with-flints continue to increase. The zero findspot density at 21.95% Clay-with-flints relates to the Dagnall to Tring interfluve.

Fig. 9.10 Relationship between Clay-with-flints survival and findspot density on the South Chilterns.



There are only three interfluves in the South Chilterns, meaning there are only three data points, all tightly grouped between 4.43 and 5.94 findspots per 100km^2. This is insufficient to create a meaningful pattern of relationships.

It is clear from all three areas that, except perhaps on the South Chilterns, it is the areas with low surviving percentages of Clay-with-flints which have the lowest findspot density, as predicted by my hypothesis. This is because the most heavily-eroded Clay-with-flints has released the highest number of artefacts, which have been removed subsequently by later periglacial processes. In each area, findspot density then climbs until it peaks and begins to fall as Clay-with-flints survival continues to increase, preserving rather than releasing artefacts. There is no linear relationship between the two, no perfect sine curve and the peaks are different in each area but the general principle holds true.

Findspots on the edges of Clay-with-flints

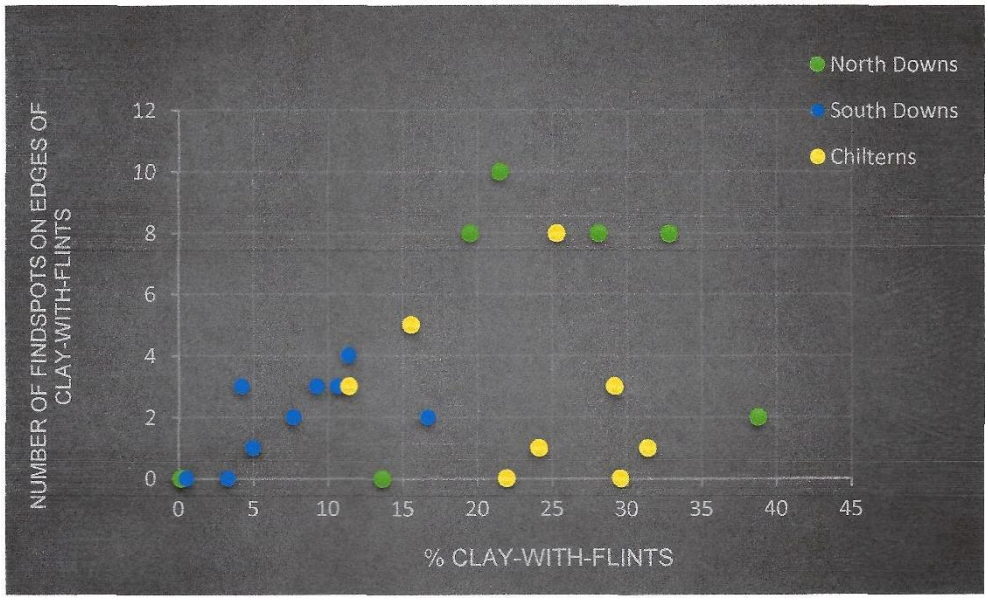
On the shoulders of valleys and the scarp slope, Clay-with-flints *sensu lato* residual surface deposits feather out to expose the Clay-with-flints *sensu stricto* (Catt 2010). This increases the potential for artefact release and leads to surface assemblages eroding at plateau and terrace edges. To assess the implications of this for the archaeological record I assessed by eye the locations of findspots in each study area at a map scale of 1:80,000. Table 9.4 shows the results of my assessment.

As Fig. 9.11 demonstrates, there is no clear relationship between the % Clay-with-flints survival and number of findspots on the edge of Clay-with-flints when assessed at individual interfluve level. However, as Table 9.4 demonstrates, although overall % Clay-with-flints survival on the South Downs is by far the lowest of my three study areas, the number of findspots on the edges of that Clay-with-flints is significantly highest. Except on interfluves where there are no findspots, the number of South Downs findspots on the edge of Clay-with-flints never falls below 20% as a percentage of total findspots. Overall, it is 26.8%.

Table 9.3 Number of findspots on the edges of Clay-with-flints deposits and their % of total findspots on each interfluve, assessed by eye.

Location	% Clay-with-flints	Findspots on edges of C-w-f	% of total findspots
South Downs			
Eastbourne – Cuckmere	10.61	3	20.00
Cuckmere – Ouse	5.00	1	20.00
Ouse – Adur	4.20	3	33.00
Adur – Arun	9.21	3	60.00
Arun – Lavant	0.53	0	0.00
Lavant – Ems	3.31	0	0.00
Ems – Meon	7.66	2	22.00
Meon – Itchen	16.67	2	50.00
Itchen-Test	11.36	4	33.00
Totals	**6.84%**	***18***	***26.80%***
Chilterns			
Hitchin – Lilley Bottom	11.38	3	50.00
Lilley Bottom-Luton	24.14	1	11.10
Luton – Dunstable	25.29	8	34.80
Dunstable- Dagnall	29.15	3	30.00
Dagnall-Tring	21.95	0	0.00
Tring-Wendover	31.41	1	6.25
Wendover-Princes Risboro'	29.56	0	0.00
Princes Risboro'-Goring	15.56	5	14.70
Total	***22.71%***	***21***	***19.60%***
North Downs			
Folkestone – Great Stour	21.49	10	30.30
Great Stour-Medway	38.74	2	12.50
Medway – Darent	19.49	8	12.10
Darent - Merstham	32.81	8	19.00
Merstham - Mole	28.07	8	27.60
Mole-Wey	13.64	0	0.00
Wey – Blackwater-Loddon	0.17	0	0.00
Total	***26.77%***	***36***	***19.40%***

Fig. 9.11 Relationship between number of findspots on the edges of Clay-with-flints deposits and % Clay-with-flints survival.



This figure plots the relationship between the number of findspots on the edges of surviving Clay-with-flints deposits on each interfluve and % Clay-with-flints survival. It shows no clear relationship between the two.

On the Chilterns and North Downs, where total Clay-with-flints survival is 22.71% and 26.77% respectively, the number of findspots on the edges of Clay-with-flints falls to 19.6% and 19.4% respectively. While not definitive, this suggests that, in line with my working hypothesis, the preservational qualities of the denser Clay-with-flints may be reducing the percentage of artefacts released, while feathering around the edges of the patchy deposits on the South Downs may be releasing more of the archaeology into the record.

Head deposits

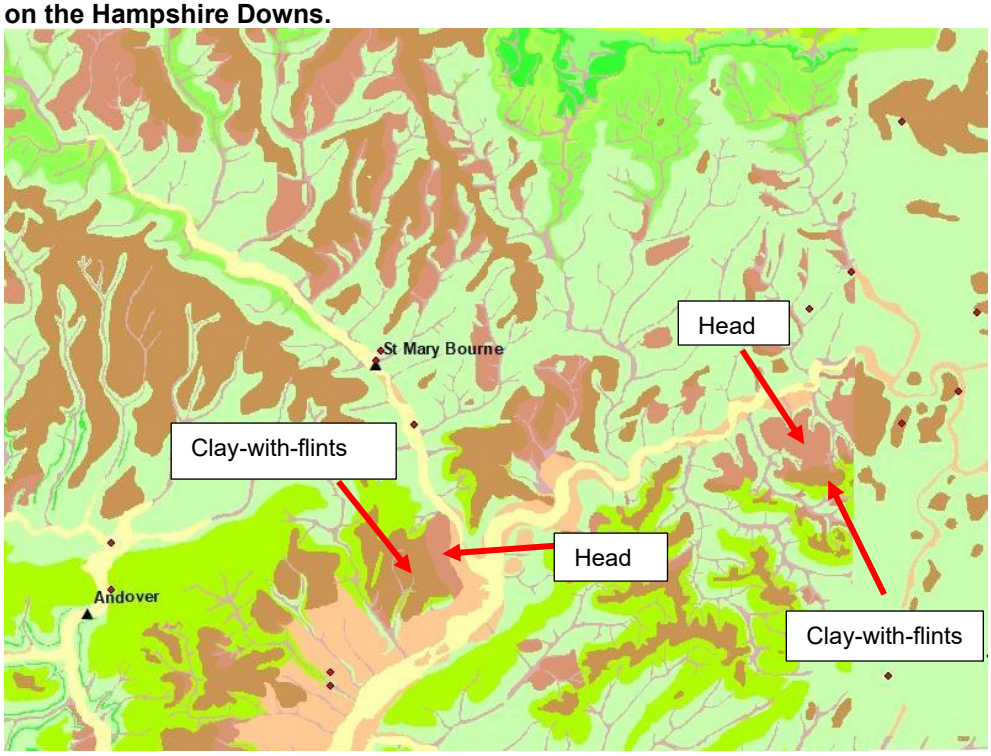
Colluviation is one of the most important post-depositional factors affecting the archaeology of the Chalk (Bell 1983, 147). Analysis of my geological findspot distribution maps showed that 233 (13%) findspots lay on Chalk, 127 (7.2%) on Clay-with-flints and 109 (6.2%) on colluvial Head deposits. The remainder of the findspots in my dataset (1,303 or 73.5%) lie on remnant Palaeogene bedrock such as the Thanet Formation and Lambeth Group, Pleistocene glacio-fluvial deposits, various Pleistocene Thames Valley gravels, river terrace gravels and raised beach marine deposits. When Clay-with-flints is soliflucted and comes to rest on an inclined surface on a hillside then it is classified as Head (https://www.bgs.ac.uk/lexicon/lexicon.cfm?pub=CWF), a poorly sorted

and poorly stratified polymict deposit with a variable sand/clay content, depending on its upslope source and distance from source (https://www.bgs.ac.uk/lexicon/lexicon.cfm?pub=HEAD). A particularly clear example of this transition can be seen on Map 9.1 below.

Head is formed mostly by solifluction and/or hillwash and soil creep, meaning the artefacts found within dry valley bottoms have come largely from the plateaux tops or valley sides and should be taken into account as part of the archaeological record of the plateaux. The number of finds on Head identified on the slopes and valley bottoms between the interfluves in my core study areas is detailed in table 9.3.

Brickearth deposits in Swale, Thanet, Dover and Canterbury contain an unusually high representation of Mousterian bout coupé handaxes (Kent County Council 2018, 6). Based on studies of dry valley sediments in Sussex (Bell 1983; Kerney *et al.* 1963; Wilkinson 2003) most brickearth is thought to have been laid down during the peak of the Last Glacial Maximum ~20ka, therefore having low Palaeolithic potential. However, at Dreal's Farm, Elham (TR 194 443), brickearth capping Clay-with-flints yielded OSL dates of 119.91±18.61 and 143.25±23.65 ka, indicating that

Map 9.1 Example of transition from Clay-with-flints to Head on a valley side on the Hampshire Downs.



(Geological Map Data BGS©UKRI 2019). For geology legend see following page.

Geology Legend

- Findspots
- ▲ Towns
- ▲ Towns

ew299_winchester_superficial

LEX_RCS_I

ALV-XCZSV	*ALLUVIUM - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
T2T4-XSV	*RIVER TERRACE DEPOSITS, 2 TO 4 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD1A-XSV	*RIVER TERRACE DEPOSITS, 1A - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD1B-XSV	*RIVER TERRACE DEPOSITS, 1B - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XCZSV	*HEAD - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XVSZC	*HEAD - GRAVEL, SAND, SILT AND CLAY [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD1-XCZSV	*HEAD, 1 - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
PEAT-P	*PEAT - PEAT [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD1-XSV	*RIVER TERRACE DEPOSITS, 1 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD2-XSV	*RIVER TERRACE DEPOSITS, 2 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD3-XSV	*RIVER TERRACE DEPOSITS, 3 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD4-XSV	*RIVER TERRACE DEPOSITS, 4 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD5-XSV	*RIVER TERRACE DEPOSITS, 5 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD7-XSV	*RIVER TERRACE DEPOSITS, 7 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD8-XSV	*RIVER TERRACE DEPOSITS, 8 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTDU-XCZ	*RIVER TERRACE DEPOSITS (UNDIFFERENTIATED) - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTDU-XSV	*RIVER TERRACE DEPOSITS (UNDIFFERENTIATED) - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
T2T3-XSV	*RIVER TERRACE DEPOSITS, 2 TO 3 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
T5T6-XSV	*RIVER TERRACE DEPOSITS, 5 TO 6 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
TUFA-CATUFA	*TUFA - TUFA, CALCAREOUS*
CWF-XCZSV	*CLAY-WITH-FLINTS FORMATION - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*

ew299_winchester_bedrock

LEX_RCS_I

WTT-SSCL	*WITTERING FORMATION - SAND, SILT AND CLAY*
LC-CLSISA	*LONDON CLAY FORMATION - CLAY, SILT AND SAND*
LMBE-CLSISA	*LAMBETH GROUP - CLAY, SILT AND SAND*
LMBE-SANDU	*LAMBETH GROUP - SAND*
LMBE-SV	*LAMBETH GROUP - SAND, GRAVELLY [UNLITHIFIED DEPOSITS CODING SCHEME]*
RB-SANCL	*READING FORMATION - SAND AND CLAY*
RB-SANDU	*READING FORMATION - SAND*
NU-CLSISA	*NURSLING SAND MEMBER - CLAY, SILT AND SAND*
WHI-SANDU	*WHITECLIFF SAND MEMBER - SAND*
WHI-SV	*WHITECLIFF SAND MEMBER - SAND, GRAVELLY [UNLITHIFIED DEPOSITS CODING SCHEME]*
CUCK-CHLK	*CULVER CHALK FORMATION - CHALK*
PCK-CHLK	*PORTSDOWN CHALK FORMATION - CHALK*
SPCH-CHLK	*SPETISBURY CHALK MEMBER - CHALK*
TACH-CHLK	*TARRANT CHALK MEMBER - CHALK*
NCK-CHLK	*NEWHAVEN CHALK FORMATION - CHALK*
STRK-LMST	*STOCKBRIDGE ROCK MEMBER - LIMESTONE*
SECK-CHLK	*SEAFORD CHALK FORMATION - CHALK*
LECH-CHLK	*LEWES NODULAR CHALK FORMATION - CHALK*
NPCH-CHLK	*NEW PIT CHALK FORMATION - CHALK*
HCK-CHLK	*HOLYWELL NODULAR CHALK FORMATION - CHALK*
ZZCH-CHLK	*ZIG ZAG CHALK FORMATION - CHALK*

ew283_andover_superficial

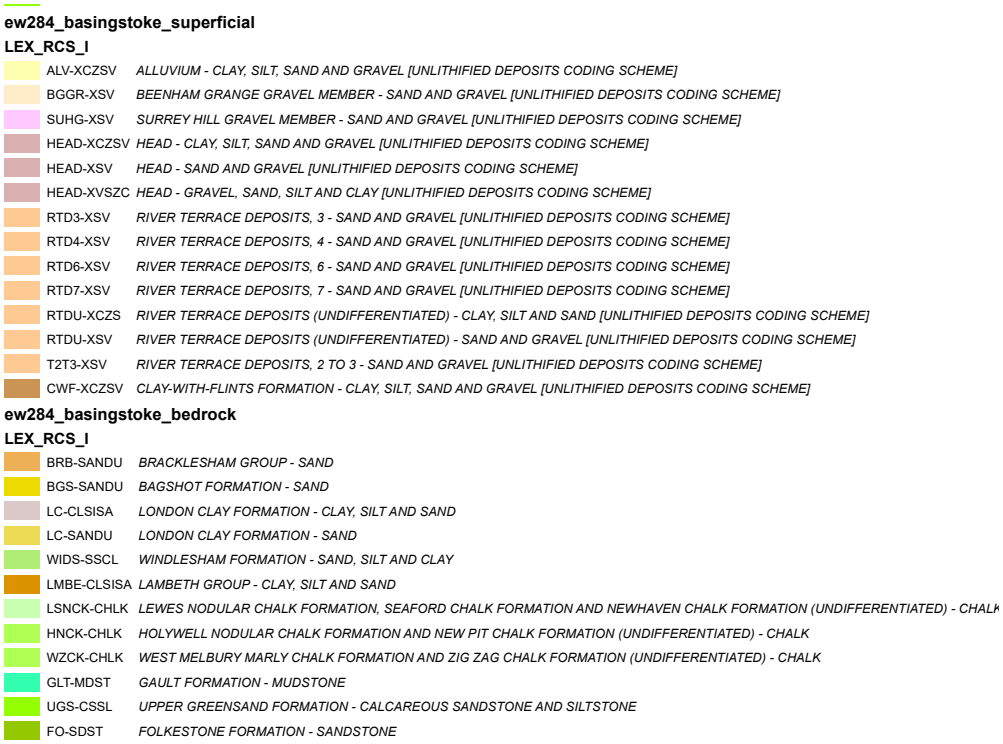
LEX_RCS_I

ALV-XCSV	*ALLUVIUM - CLAY, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
ALV-XCZSV	*ALLUVIUM - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
ALV-XSZC	*ALLUVIUM - SAND, SILT AND CLAY [UNLITHIFIED DEPOSITS CODING SCHEME]*
T2T4-XSV	*RIVER TERRACE DEPOSITS, 2 TO 4 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
T3T4-XSV	*RIVER TERRACE DEPOSITS, 3 TO 4 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-V	*HEAD - GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-VC	*HEAD - GRAVEL, CLAYEY [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XCZSV	*HEAD - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD1-V	*HEAD, 1 - GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD1-XCZSV	*HEAD, 1 - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD1-XSV	*RIVER TERRACE DEPOSITS, 1 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD2-XSV	*RIVER TERRACE DEPOSITS, 2 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTDU-XSV	*RIVER TERRACE DEPOSITS (UNDIFFERENTIATED) - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
T6T8-XSV	*RIVER TERRACE DEPOSITS, 6 TO 8 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
CWF-VC	*CLAY-WITH-FLINTS FORMATION - GRAVEL, CLAYEY [UNLITHIFIED DEPOSITS CODING SCHEME]*
CWF-XCSV	*CLAY-WITH-FLINTS FORMATION - CLAY, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
CWF-XCZSV	*CLAY-WITH-FLINTS FORMATION - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
SUPNM-UKNOWN	*SUPERFICIAL THEME NOT MAPPED [FOR DIGITAL MAP USE ONLY] - UNKNOWN/UNCLASSIFIED ENTRY*

ew283_andover_bedrock

LEX_RCS_I

LC-CLSISA	*LONDON CLAY FORMATION - CLAY, SILT AND SAND*
LC-SANDU	*LONDON CLAY FORMATION - SAND*
LMBE-CLSISA	*LAMBETH GROUP - CLAY, SILT AND SAND*
CUCK-CHLK	*CULVER CHALK FORMATION - CHALK*
NCK-CHLK	*NEWHAVEN CHALK FORMATION - CHALK*
STRK-LMST	*STOCKBRIDGE ROCK MEMBER - LIMESTONE*
SECK-CHLK	*SEAFORD CHALK FORMATION - CHALK*
LECH-CHLK	*LEWES NODULAR CHALK FORMATION - CHALK*
NPCH-CHLK	*NEW PIT CHALK FORMATION - CHALK*
HCK-CHLK	*HOLYWELL NODULAR CHALK FORMATION - CHALK*
WMCH-CHLK	*WEST MELBURY MARLY CHALK FORMATION - CHALK*
ZZCH-CHLK	*ZIG ZAG CHALK FORMATION - CHALK*
UGS-SDST	*UPPER GREENSAND FORMATION - SANDSTONE*


ew284_basingstoke_superficial
LEX_RCS_I
ALV-XCZSV ALLUVIUM - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]
BGGR-XSV BEENHAM GRANGE GRAVEL MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]
SUHG-XSV SURREY HILL GRAVEL MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]
HEAD-XCZSV HEAD - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]
HEAD-XSV HEAD - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]
HEAD-XVSZC HEAD - GRAVEL, SAND, SILT AND CLAY [UNLITHIFIED DEPOSITS CODING SCHEME]
RTD3-XSV RIVER TERRACE DEPOSITS, 3 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]
RTD4-XSV RIVER TERRACE DEPOSITS, 4 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]
RTD6-XSV RIVER TERRACE DEPOSITS, 6 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]
RTD7-XSV RIVER TERRACE DEPOSITS, 7 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]
RTDU-XCZS RIVER TERRACE DEPOSITS (UNDIFFERENTIATED) - CLAY, SILT AND SAND [UNLITHIFIED DEPOSITS CODING SCHEME]
RTDU-XSV RIVER TERRACE DEPOSITS (UNDIFFERENTIATED) - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]
T2T3-XSV RIVER TERRACE DEPOSITS, 2 TO 3 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]
CWF-XCZSV CLAY-WITH-FLINTS FORMATION - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]
ew284_basingstoke_bedrock
LEX_RCS_I
BRB-SANDU BRACKLESHAM GROUP - SAND
BGS-SANDU BAGSHOT FORMATION - SAND
LC-CLSISA LONDON CLAY FORMATION - CLAY, SILT AND SAND
LC-SANDU LONDON CLAY FORMATION - SAND
WIDS-SSCL WINDLESHAM FORMATION - SAND, SILT AND CLAY
LMBE-CLSISA LAMBETH GROUP - CLAY, SILT AND SAND
LSNCK-CHLK LEWES NODULAR CHALK FORMATION, SEAFORD CHALK FORMATION AND NEWHAVEN CHALK FORMATION (UNDIFFERENTIATED) - CHALK
HNCK-CHLK HOLYWELL NODULAR CHALK FORMATION AND NEW PIT CHALK FORMATION (UNDIFFERENTIATED) - CHALK
WZCK-CHLK WEST MELBURY MARLY CHALK FORMATION AND ZIG ZAG CHALK FORMATION (UNDIFFERENTIATED) - CHALK
GLT-MDST GAULT FORMATION - MUDSTONE
UGS-CSSL UPPER GREENSAND FORMATION - CALCAREOUS SANDSTONE AND SILTSTONE
FO-SDST FOLKESTONE FORMATION - SANDSTONE

plateau brickearth deposits capping high ground may be substantially earlier than the late Devensian, with high Palaeolithic potential (Kent County Council 2018,59).

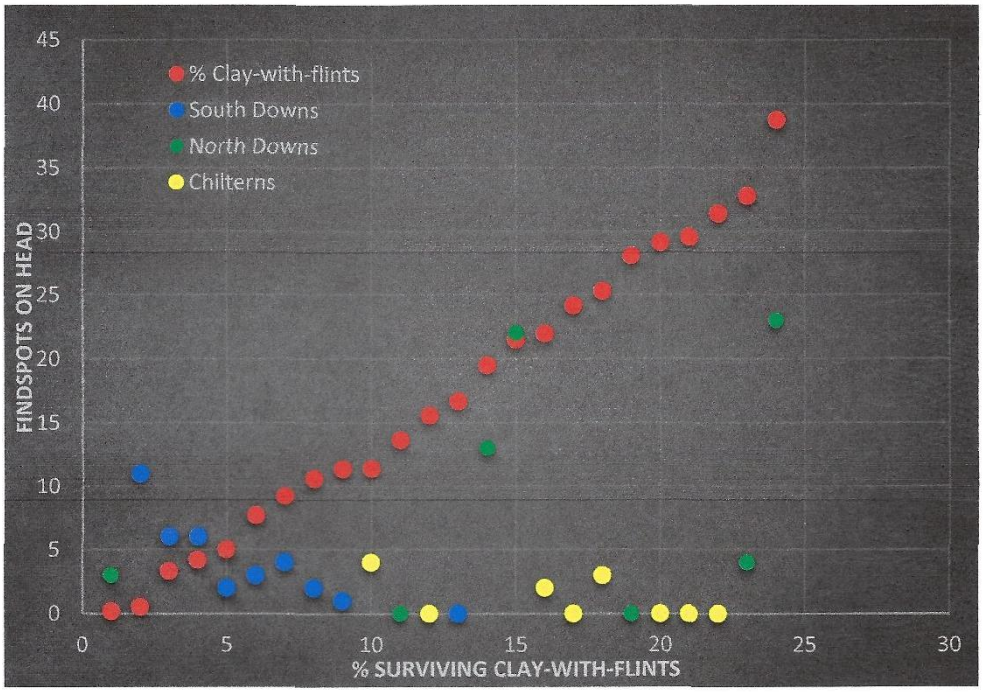
Fig. 9.12 shows the relationship between percentage surviving Clay-with-flints and the number of findspots on Head deposits. Five Chiltern interfluves, two North Downs interfluves and one South Downs interfluve had no findspots on Head so do not show on the chart. Five of those eight had high percentage Clay-with-flints survival. These were Luton to Lilley Bottom (24.14%), Dagnall to Dunstable (29.15%), Wendover–Tring (31.41%), Princes Risborough-Wendover (29.56%). and Merstham-Mole (28.07%). The remaining three – Goring to Princes Risborough (15.56%), Mole-Wey (13.64%) and Meon-Itchen (16.67) had medium Clay-with-flints survival.

Once released from the Clay-with-flints, artefacts are vulnerable and there is no way of knowing how many were released into subsequently soliflucted deposits and have since disappeared. Although my results do not, in general, show a clear relationship between Clay-with-flints survival and the number of findspots mapped onto Head, there is a relationship on the South Downs (Fig. 9.12) where overall Clay-with-flints survival is lowest.

Table 9.4 Number of findspots on Head in relation to surviving % Clay-with-flints on each interfluve.

Location	% surviving Clay-with-flints	Find spot entries on Head
South Downs		
Eastbourne - Cuckmere	10.61	2
Cuckmere - Ouse	5.00	2
Ouse - Adur	4.20	6
Adur - Arun	9.21	4
Arun - Lavant	0.53	11
Lavant – Ems	3.31	6
Ems – Meon	7.66	3
Meon – Itchen	16.67	0
Itchen-Test	11.36	1
Totals	**6.84%**	***35***
Chilterns		
Goring - Princes Risborough.	15.56	0
Princes Risborough - Wendover	29.56	0
Wendover-Tring	31.41	0
Tring-Dagnall	21.95	2
Dagnall-Dunstable	29.15	0
Dunstable-Luton	25.29	3
Luton-Lilley Bottom	24.14	0
Lilley Bottom-Hitchin	11.38	4
Total	***22.71%***	***9***
North Downs		
Folkestone – Great Stour	21.49	22
Great Stour-Medway	38.74	23
Medway - Darent	19.49	13
Darent - Merstham	32.81	4
Merstham - Mole	28.07	0
Mole-Wey	13.64	0
Wey – Blackwater-Loddon	0.17	3
Total	***26.77%***	***65***

Fig. 9.12 Relationship between number of findspots on Head and % surviving Clay-with-flints.



My visualisation of the relationship between geomorphology and findspot distribution has identified the areas and landscape zones of the Chalk uplands with the greatest archaeological potential. They include interfluves with Clay-with-flints survival which is at or around the median for their landscape region (21.49% and 24.14% respectively on the North Downs and Chilterns); areas around the perimeter of Clay-with-flints deposits and those between the edges of such deposits and the escarpment, especially where there are also wide views over the surrounding landscape. The perimeter of the fragmented Clay-with-flints on the South Downs, which has yielded 26.8% of the known finds from the Chalk uplands of that study area, could prove especially fruitful.

Given their good preservational capability, areas with the densest Clay-with-flints survival also have high archaeological potential - e.g. the Great Stour to Medway interfluve on the North Downs has 38.74% Clay-with-flints survival but a findspot density of only 4.19 per 100km^2/38.6mi^2. Such areas would, however, require carefully targeted excavation.

The South Downs have a relatively low findspot density – they also have the lowest and most fragmented % of surviving Clay-with-flints. In addition, their archaeological record was largely unaffected by aggregates/brickearth

extraction or urbanisation, untouched by railway construction and by-passed by large-scale collecting. Despite this, the Eastbourne-Cuckmere interfluve is one of only three interfluves across all my study areas to have a disproportionately high findspot density in relation to its Clay-with-flints survival ((22.73 per 100km^2/38.6mi^2 with only 10.61% Clay-with-flints). For the other two interfluves – Dunstable to Luton in the Chilterns and Medway to Darent on the North Downs – the disproportion can be accounted for by particularly assiduous antiquarian collecting and/or late 19th/early 20th century industrialisation. Neither explanation will account for the Eastbourne to Cuckmere anomaly. This raises the strong possibility that, for once, what we are seeing is indeed "*directly observable 'meaningful' information about the past"* (Binford 1972, 252). Woodcock (1981) lists dozens of handaxes and flakes from the Crowlink and Birling area alone and Garraway-Rice (1911, 372) mentions 105 'hilltop palaeoliths' from around Friston in the Hewlett collection (the latter now lost so not included in my British Lower-Middle Palaeolithic Chalklands dataset). The Archaeology Data Service entries in respect of palaeoliths found in the area note that further finds are likely to be made (https://www.archaeologydataservice.ac.uk/archsearch/record?titleId=1767837) and this interfluve and its surrounding areas clearly have significant future archaeological potential. My proposal that its archaeological record constitutes a real reflection of early human landscape use also needs testing.

Sites such as Caddington Cottages, Chilterns and Gauville 'Bout de la Route du Bois', Somme (one of only two known Late Middle Palaeolithic sites from northern France) have demonstrated the capacity of dolines and other solution hollows to preserve primary context Palaeolithic archaeology. There are relatively high concentrations of dolines in the London Basin, thanks to its extensive Neogene deposits and better-preserved erosion surfaces. The Kent Downs have an overall doline density of 47 per 100km^2/38.6mi^2 but these are concentrated in Surrey and West Kent, where doline density is 63 per 100km$^{2/}$38.6mi^2 (Edmonds 1983), Similarly, there are >1000 known dolines, sinkholes and solution pipes concentrated in the West Chilterns (Worsley 2016), making them areas with great potential for finding preserved Lower-Middle Palaeolithic archaeology.

It is not easy to Identify areas of the landscape which are genuinely blank (i.e. interfluves on which the percentage of surviving Clay-with-flints favours artefact release but where people have searched and failed to find Lower-Middle Palaeolithic archaeology) as SERPP/TERPP and the HERs record only the archaeology that has been found, not where abortive searches have taken place. Such identification might be achieved by identifying every recorded fieldwalking exercise, archaeological survey or excavation carried out on the relevant interfluves (e.g. via the Archaeology Data Service database - https://www.archaeologydataservice.ac.uk/ - or from local authority planning applications) and establishing those during which no Lower-Middle Palaeolithic finds were made. It is equally difficult to define what would constitute a genuine signal of human absence, given the low level and diffuse nature of the British Lower-Middle Palaeolithic archaeological signature, especially during and after MIS7. Where it could be shown that no archaeology has been found despite extensive investigation then this might indicate genuine human absence, always provided those investigations had reached the true Middle Pleistocene 'natural'. The fact that the large-scale Seven Sisters Archaeology project in the Birling Gap area (https://www.nationaltrust.org.uk/birling-gap-and-the-seven-sisters/projects/amazing-archaeology-at-seven-sisters) identified nothing earlier than the Mesolithic, despite the large number of Lower-Middle Pleistocene artefacts known from the Crowlink and Birling area (Woodcock 1981) and their anomalously high density in relation to Clay-with-flints survival demonstrated in my thesis, suggests that this is not always the case. Given the hunter-gatherer nature of Middle Pleistocene life and their operating radius of between 20km/12.4mi and 40km/24.8mi (Gamble 2009a) it is likely that, in the small scale Chalk landscapes of southeast Britain, people ranged across neighbouring interfluves whether or not they left any archaeologically visible evidence of their passing.

For reasons explained in Chapters 4 and 5 (*Materials and Methods* and *Geomorphology of the Chalk uplands*), it was not possible to carry out the same detailed analysis for the Somme valley uplands where the dense loess, often several metres thick, has left any surviving Clay-with-flints and archaeology deeply buried.

iii) Visualising the relationship between late 19th/early 20th century industrialisation processes and findspot distribution.

Under this heading I considered the opportunities for the preservation and subsequent release of lithic artefacts into the archaeological record created by late 19th/early 20th century industrialisation. To do so I analysed the discovery circumstances of each of my 1772 British and 167 French total dataset entries, regardless of their geological context. I then allocated those dataset entries with an individual HER, PAS or SRPP/TERPP number but which shared a single NGR that had mapped onto the Chalk footprint of an interfluve to their respective interfluve from my site lists before calculating the resultant findspot density.

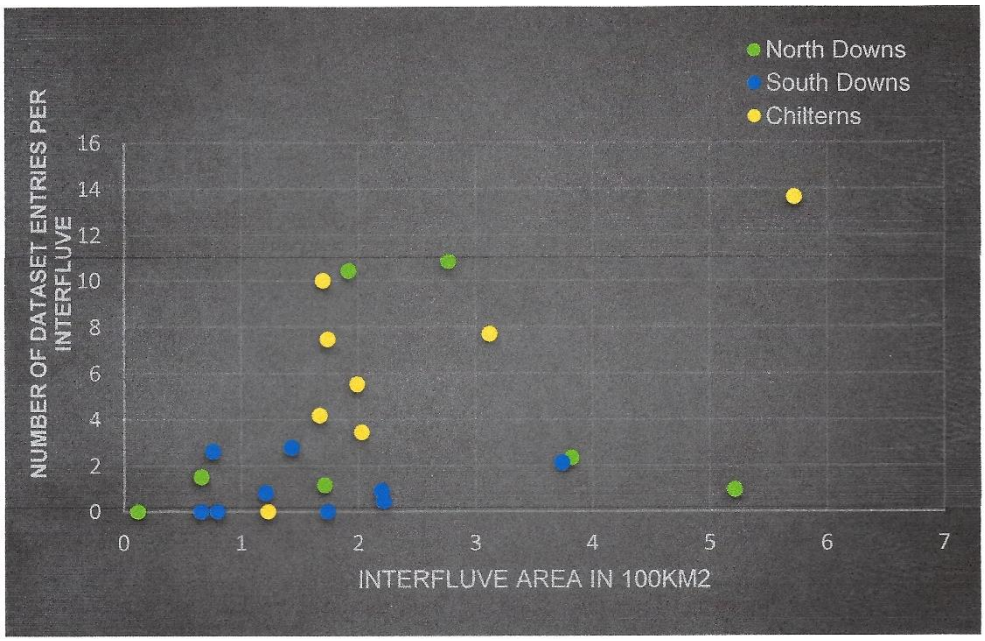
The variables included in my analyses were aggregates and brickearth extraction, railway construction, urbanisation and infrastructure development. Together these were responsible for 26.7% of the 1772 total entries in my British Lower-Middle Palaeolithic Chalklands dataset. Their cumulative impact on findspot density and distribution was, therefore, significant. Coupled with the new understanding of human antiquity after 1859, the boom in industrialisation created an ideal environment to foster antiquarian and public interest in Palaeolithic archaeology. It offered a perfect opportunity for collectors to access Pleistocene deposits and recover artefacts (Harris *et al.* 2019).

Fig. 9.13 shows the cumulative impact of this industrialisation on findspot distribution patterns. In this case, the area of the Chalk interfluve in 100km^2 is used, rather than % surviving Clay-with-flints, which has no relevance to the preservation or release of artefacts in the context of the industrial processes considered here.

Gravel and brickearth extraction

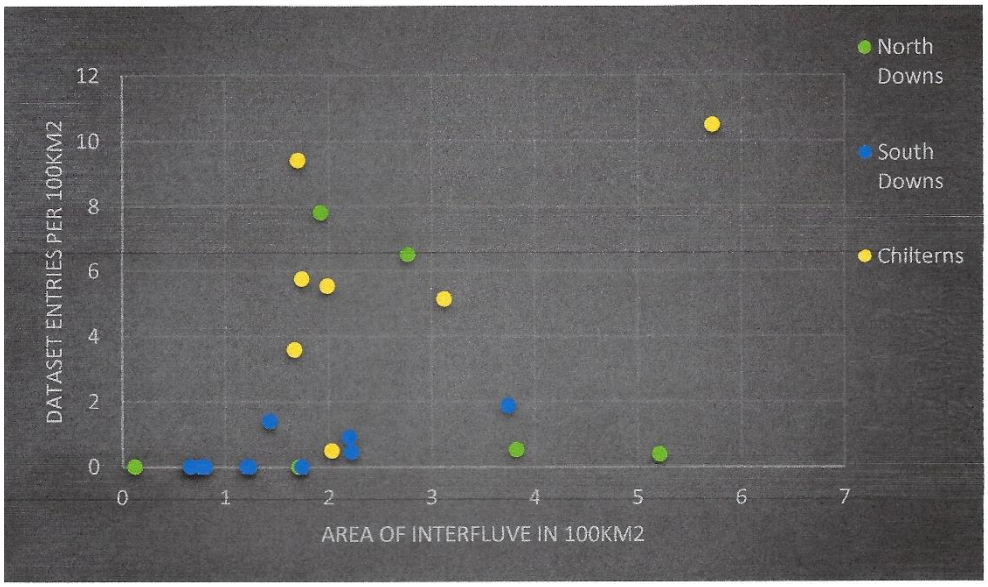
There was an upsurge from the 1860s onwards in gravel, sand and brickearth extraction to meet the demands of Britain's expanding urban landscape and infrastructure. Fig. 9.14 shows the gravel and brickearth pit finds density on each interfluve. There were nine interfluves on which there were no gravel or brick pits which had finds attributed to them in any of my sources.

Fig. 9.13 Cumulative impact of all late 19th/early 20th century industrialisation processes on my core study areas



This figure compares the differing cumulative effects of all the processes involved in late 19th/early 20th century industrialisation on findspot distribution patterns in my three core study areas. Their comparatively very limited impact on the South Downs is clear. The dataset entries were not individually mapped onto the geology maps but were allocated to their respective interfluves from analysis of my site lists. (Refers to Fig. 9.13 above).

Fig. 9.14. Density of Chalklands Lower-Middle Palaeolithic dataset entries attributable to gravel and/or brickearth extraction.



As with figure 9.13, the numbers of dataset entries were not individually mapped onto the geology maps but were allocated to their respective interfluves from analysis of my site lists

They include five of the nine South Downs interfluves, one in the Chilterns (again the Dagnall to Tring interfluve) and three on the North Downs. Table 9.5 lists the number of gravel and brick pits on each interfluve, to which these dataset entries are attributed.

The strong similarity in the density patterns in Figs. 9.13 and 9.14 demonstrates that, of all the industrialisation processes, it was aggregates and brickearth extraction that had by far the greatest impact on the archaeological record.

The greatest concentration of gravel pits (54) lay on the Thames dipslope on the Princes Risborough to Goring interfluve of the Chilterns. Of these, 18 were at Maidenhead and 13 at Reading, which are about 20.92kms (13) apart. The remainder were distributed over a Chalk interfluve area of 5.72 100km^2. The next highest concentration was the 11 gravel pits on the Luton to Dunstable interfluve, again spread over the whole interfluve. In stark contrast, on the Medway to Darent interfluve (2.77 100km^2) 9 of the 11 gravel pits were concentrated in the small civil parish of Swanscombe and Greenhithe (Map 9. 2).

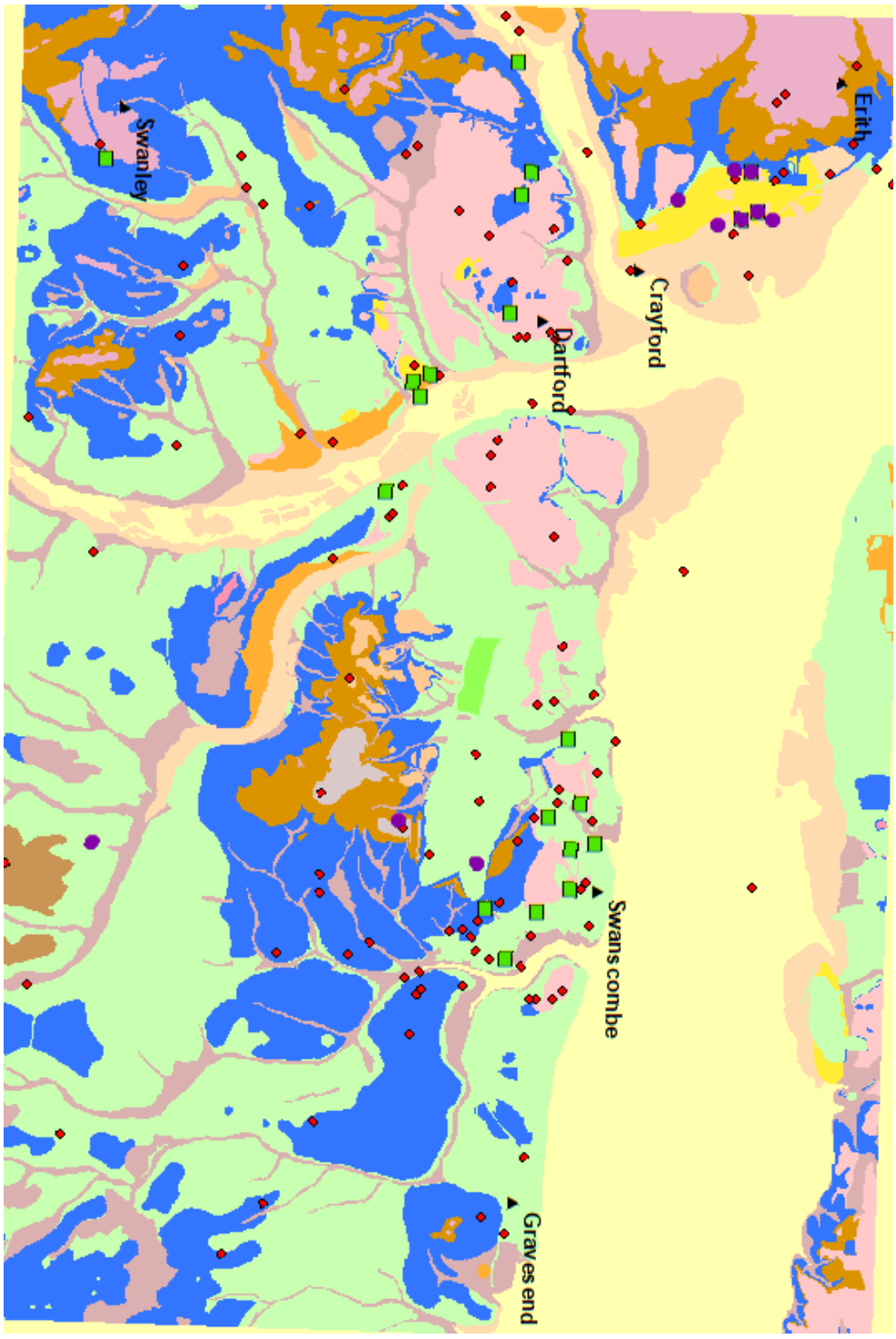
The Ebbsfleet Valley, which cut at right-angles through the Thames deposits between Swanscombe and Northfleet, is probably the most important location for post-Hoxnian and pre-Devensian Palaeolithic sites in Britain (Wessex Archaeology 1993a, 114). To the east of Barnfield Pit and Swanscombe village, where Chalk has been dug in large quantities since the latter part of the 19th century, the quarries gradually coalesced to make one great gash in the landscape from Northfleet to Springhead. Among the former pits incorporated were Galley Hill Pit, Rickson's Pit, Southfleet and Baker's Hole, even the smaller of these producing large numbers of finds. As discussed in Chapter Seven, during the late 19th and early 20th centuries this was a favourite place for collectors, archaeologists and geologists (Wymer 1968, 332) who flocked to inspect the expanses of Pleistocence deposits exposed.

There were also numerous gravel and brickearth pits just off the Chalk footprints of 10 of the interfluves from which finds were made. These are excluded from Table 9.5 but are included in my 1772 total dataset entries (*cf.* footnote to Table 6.3).

Gravel and brickearth extraction not only added enormous numbers of artefacts to the archaeological record but also resulted in the identification of rare primary context Lower-Middle Palaeolithic sites. The brick pits at Crayford and Erith yielded two primary context 'working floors', Spurrell's 'chipping floor' in the prolific Stoneham's Pit (Spurrell 1880b) and the small

Levallois working floor discovered by Chandler in Rutter's Pit. Chandler considered this to be probably part of the same working floor as Spurrell's,

Map 9.2. Gravel pits in the Swanscombe-Greenhithe area. *(Gravel pits represented by green squares, brick pits by purple circles. In the Crayford/Erith area three gravel pit squares are overlain by purple brick pit circles)*



(Geological Map Data BGS©UKRI 2019). For geology legend see following pages.

Geology Legend

- Towns
- Kent brickearth pits
- Kent gravel pits
- Harrison findspots
- Findspots

ew288_maidstone_superficial

LEX_RCS_I

ALV-CZPS	*ALLUVIUM - CLAY, SILTY, PEATY, SANDY [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XCZ	*HEAD - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XCZSV	*HEAD - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XVSZC	*HEAD - GRAVEL, SAND, SILT AND CLAY [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XZV	*HEAD - SILT AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD1-XSV	*RIVER TERRACE DEPOSITS, 1 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD2-XSV	*RIVER TERRACE DEPOSITS, 2 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD3-XSV	*RIVER TERRACE DEPOSITS, 3 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD4-XSV	*RIVER TERRACE DEPOSITS, 4 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD5-XSV	*RIVER TERRACE DEPOSITS, 5 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTDU-XCZ	*RIVER TERRACE DEPOSITS (UNDIFFERENTIATED) - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
TUFA-CATUFA	*TUFA - TUFA, CALCAREOUS*
CWF-XCZSV	*CLAY-WITH-FLINTS FORMATION - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*

ew288_maidstone_bedrock

LEX_RCS_I

LNM-SANDU	*LENHAM FORMATION - SAND*
TAB-SSCL	*THANET FORMATION - SAND, SILT AND CLAY*
SECK-CHLK	*SEAFORD CHALK FORMATION - CHALK*
LECH-CHLK	*LEWES NODULAR CHALK FORMATION - CHALK*
NPCH-CHLK	*NEW PIT CHALK FORMATION - CHALK*
HCK-CHLK	*HOLYWELL NODULAR CHALK FORMATION - CHALK*
WMCH-CHLK	*WEST MELBURY MARLY CHALK FORMATION - CHALK*
WZCK-CHLK	*WEST MELBURY MARLY CHALK FORMATION AND ZIG ZAG CHALK FORMATION (UNDIFFERENTIATED) - CHALK*
ZZCH-CHLK	*ZIG ZAG CHALK FORMATION - CHALK*
GLT-MDST	*GAULT FORMATION - MUDSTONE*
AC-STMD	*ATHERFIELD CLAY FORMATION - SANDSTONE AND MUDSTONE*
FO-SDST	*FOLKESTONE FORMATION - SANDSTONE*
HY-SDLM	*HYTHE FORMATION - SANDSTONE AND [SUBEQUAL/SUBORDINATE] LIMESTONE, INTERBEDDED*
SAB-SDSM	*SANDGATE FORMATION - SANDSTONE, SILTSTONE AND MUDSTONE*
WC-LMST	*WEALD CLAY FORMATION - LIMESTONE*
WC-MDST	*WEALD CLAY FORMATION - MUDSTONE*
WC-SDST	*WEALD CLAY FORMATION - SANDSTONE*
TWS-MDST	*TUNBRIDGE WELLS SAND FORMATION - MUDSTONE*
TWS-SDSL	*TUNBRIDGE WELLS SAND FORMATION - SANDSTONE AND SILTSTONE, INTERBEDDED*
WDC-MDST	*WADHURST CLAY FORMATION - MUDSTONE*

ew287_sevenoaks_superficial

LEX_RCS_I

ALV-XCZSV	*ALLUVIUM - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
T1T2-XSV	*RIVER TERRACE DEPOSITS, 1 TO 2 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XCZSV	*HEAD - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD1-XSV	*RIVER TERRACE DEPOSITS, 1 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD2-XSV	*RIVER TERRACE DEPOSITS, 2 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD3-XSV	*RIVER TERRACE DEPOSITS, 3 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD4-XSV	*RIVER TERRACE DEPOSITS, 4 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTDU-XCZ	*RIVER TERRACE DEPOSITS (UNDIFFERENTIATED) - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
CWF-XCZSV	*CLAY-WITH-FLINTS FORMATION - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
DBLB-XSV	*DISTURBED BLACKHEATH BEDS - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*

ew287_sevenoaks_bedrock

LEX_RCS_I

LSNCK-CHLK	*LEWES NODULAR CHALK FORMATION, SEAFORD CHALK FORMATION AND NEWHAVEN CHALK FORMATION (UNDIFFERENTIATED) - CHALK*
NPCH-CHLK	*NEW PIT CHALK FORMATION - CHALK*
GLML-CAMDST	*GLAUCONITIC MARL MEMBER - MUDSTONE, CALCAREOUS*
HNCK-CHLK	*HOLYWELL NODULAR CHALK FORMATION AND NEW PIT CHALK FORMATION (UNDIFFERENTIATED) - CHALK*
MR-CHLK	*MELBOURN ROCK MEMBER - CHALK*
WZCK-CHLK	*WEST MELBURY MARLY CHALK FORMATION AND ZIG ZAG CHALK FORMATION (UNDIFFERENTIATED) - CHALK*
GLT-MDST	*GAULT FORMATION - MUDSTONE*
UGS-SISD	*UPPER GREENSAND FORMATION - SILTSTONE AND SANDSTONE*
AC-MDST	*ATHERFIELD CLAY FORMATION - MUDSTONE*
FO-SDST	*FOLKESTONE FORMATION - SANDSTONE*
HY-SDLM	*HYTHE FORMATION - SANDSTONE AND [SUBEQUAL/SUBORDINATE] LIMESTONE, INTERBEDDED*
SAB-STMD	*SANDGATE FORMATION - SANDSTONE AND MUDSTONE*
WC-LMST	*WEALD CLAY FORMATION - LIMESTONE*
WC-MDST	*WEALD CLAY FORMATION - MUDSTONE*
WC-SDST	*WEALD CLAY FORMATION - SANDSTONE*
ARS-SDST	*ARDINGLY SANDSTONE MEMBER - SANDSTONE*
CKST-CALSST	*CUCKFIELD STONE BED - SANDSTONE, CALCAREOUS*
GRC-MDST	*GRINSTEAD CLAY MEMBER - MUDSTONE*
LGRC-MDST	*LOWER GRINSTEAD CLAY - MUDSTONE*
LTW-SDSL	*LOWER TUNBRIDGE WELLS SAND - SANDSTONE AND SILTSTONE, INTERBEDDED*
LTW-SDSM	*LOWER TUNBRIDGE WELLS SAND - SANDSTONE, SILTSTONE AND MUDSTONE*
TWS-SDSL	*TUNBRIDGE WELLS SAND FORMATION - SANDSTONE AND SILTSTONE, INTERBEDDED*
UGRC-MDST	*UPPER GRINSTEAD CLAY - MUDSTONE*
UTW-SDSL	*UPPER TUNBRIDGE WELLS SAND - SANDSTONE AND SILTSTONE, INTERBEDDED*
WDC-FEST	*WADHURST CLAY FORMATION - IRONSTONE*
WDC-MDST	*WADHURST CLAY FORMATION - MUDSTONE*
ASD-SDSM	*ASHDOWN FORMATION - SANDSTONE, SILTSTONE AND MUDSTONE*

ew272_chatham_superficial

LEX_RCS_I

ALV-CZPS	*ALLUVIUM - CLAY, SILTY, PEATY, SANDY [UNLITHIFIED DEPOSITS CODING SCHEME]*
ALV-XCZSV	*ALLUVIUM - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
ALV-XZC	*ALLUVIUM - SILT AND CLAY [UNLITHIFIED DEPOSITS CODING SCHEME]*
KPGR-XSV	*KEMPTON PARK GRAVEL FORMATION - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
BTFU-XCZS	*BEACH AND TIDAL FLAT DEPOSITS (UNDIFFERENTIATED) - CLAY, SILT AND SAND [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XCZ	*HEAD - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XCZSV	*HEAD - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XVSZC	*HEAD - GRAVEL, SAND, SILT AND CLAY [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XZV	*HEAD - SILT AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD1-XCZ	*RIVER TERRACE DEPOSITS, 1 - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD1-XSV	*RIVER TERRACE DEPOSITS, 1 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD2-XSV	*RIVER TERRACE DEPOSITS, 2 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD3-XSV	*RIVER TERRACE DEPOSITS, 3 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD4-XSV	*RIVER TERRACE DEPOSITS, 4 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTDU-XCZ	*RIVER TERRACE DEPOSITS (UNDIFFERENTIATED) - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
CWF-XCZSV	*CLAY-WITH-FLINTS FORMATION - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*

ew272_chatham_bedrock

LEX_RCS_I

LNM-SAGR	*LENHAM FORMATION - SAND AND GRAVEL*
BGS-SANDU	*BAGSHOT FORMATION - SAND*
CLGB-CLSISA	*CLAYGATE MEMBER - CLAY, SILT AND SAND*
LC-CLSI	*LONDON CLAY FORMATION - CLAY AND SILT*
TAB-SSCL	*THANET FORMATION - SAND, SILT AND CLAY*
HWH-SAGR	*HARWICH FORMATION - SAND AND GRAVEL*
LMBE-SSCL	*LAMBETH GROUP - SAND, SILT AND CLAY*
SECK-CHLK	*SEAFORD CHALK FORMATION - CHALK*
LECH-CHLK	*LEWES NODULAR CHALK FORMATION - CHALK*
LSNCK-CHLK	*LEWES NODULAR CHALK FORMATION, SEAFORD CHALK FORMATION AND NEWHAVEN CHALK FORMATION (UNDIFFERENTIATED) - CHALK*
NPCH-CHLK	*NEW PIT CHALK FORMATION - CHALK*
GLML-CAMDST	*GLAUCONITIC MARL MEMBER - MUDSTONE, CALCAREOUS*
HCK-CHLK	*HOLYWELL NODULAR CHALK FORMATION - CHALK*
HNCK-CHLK	*HOLYWELL NODULAR CHALK FORMATION AND NEW PIT CHALK FORMATION (UNDIFFERENTIATED) - CHALK*
WMCH-CHLK	*WEST MELBURY MARLY CHALK FORMATION - CHALK*
WZCK-CHLK	*WEST MELBURY MARLY CHALK FORMATION AND ZIG ZAG CHALK FORMATION (UNDIFFERENTIATED) - CHALK*
ZZCH-CHLK	*ZIG ZAG CHALK FORMATION - CHALK*
GLT-MDST	*GAULT FORMATION - MUDSTONE*
FO-SDST	*FOLKESTONE FORMATION - SANDSTONE*

ew271_dartford_superficial

LEX_RCS_I

ALV-CZPS	*ALLUVIUM - CLAY, SILTY, PEATY, SANDY [UNLITHIFIED DEPOSITS CODING SCHEME]*
ALV-XCZSV	*ALLUVIUM - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
TRD-XCZ	*TIDAL RIVER OR CREEK DEPOSITS - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
KPGR-XSV	*KEMPTON PARK GRAVEL FORMATION - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
CFSI-XCZ	*CRAYFORD SILT MEMBER - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
HAGR-XSV	*HACKNEY GRAVEL MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
ILSI-XCZ	*ILFORD SILT MEMBER - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
LHGR-XSV	*LYNCH HILL GRAVEL MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
TPGR-XSV	*TAPLOW GRAVEL FORMATION - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
BHT-XSV	*BOYN HILL GRAVEL MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
BPGR-XSV	*BLACK PARK GRAVEL MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
STGR-XSV	*STANMORE GRAVEL FORMATION - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
WHGR-XSV	*WELL HILL GRAVEL FORMATION - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
DASI-XCZ	*DARTFORD SILT MEMBER - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XCZSV	*HEAD - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XVSZC	*HEAD - GRAVEL, SAND, SILT AND CLAY [UNLITHIFIED DEPOSITS CODING SCHEME]*
PEAT-P	*PEAT - PEAT [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTDU-XSV	*RIVER TERRACE DEPOSITS (UNDIFFERENTIATED) - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
CHGR-XSV	*CHELSFIELD GRAVEL FORMATION - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
CWF-XCZSV	*CLAY-WITH-FLINTS FORMATION - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*

ew271_dartford_bedrock

LEX_RCS_I

CLGB-SSCL	*CLAYGATE MEMBER - SAND, SILT AND CLAY*
LC-CLSI	*LONDON CLAY FORMATION - CLAY AND SILT*
TAB-SANDU	*THANET FORMATION - SAND*
HWH-SAGR	*HARWICH FORMATION - SAND AND GRAVEL*
LMBE-SSCL	*LAMBETH GROUP - SAND, SILT AND CLAY*
SNCK-CHLK	*SEAFORD CHALK FORMATION AND NEWHAVEN CHALK FORMATION (UNDIFFERENTIATED) - CHALK*
LECH-CHLK	*LEWES NODULAR CHALK FORMATION - CHALK*
LSNCK-CHLK	*LEWES NODULAR CHALK FORMATION, SEAFORD CHALK FORMATION AND NEWHAVEN CHALK FORMATION (UNDIFFERENTIATED) - CHALK*
NPCH-CHLK	*NEW PIT CHALK FORMATION - CHALK*
HCK-CHLK	*HOLYWELL NODULAR CHALK FORMATION - CHALK*
WZCK-CHLK	*WEST MELBURY MARLY CHALK FORMATION AND ZIG ZAG CHALK FORMATION (UNDIFFERENTIATED) - CHALK*
GLT-MDST	*GAULT FORMATION - MUDSTONE*
FO-SDST	*FOLKESTONE FORMATION - SANDSTONE*

ew258_259_southend_and_foulness_superficial
LEX_RCS_I
ALV-CZPS ALLUVIUM - CLAY, SILTY, PEATY, SANDY [UNLITHIFIED DEPOSITS CODING SCHEME]
ALV-XCZSV ALLUVIUM - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]
T1T2-XSV RIVER TERRACE DEPOSITS, 1 TO 2 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]
TFD-XCZ TIDAL FLAT DEPOSITS - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]
TFD-XSZ TIDAL FLAT DEPOSITS - SAND AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]
LHGR-XSV LYNCH HILL GRAVEL MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]
TPGR-XSV TAPLOW GRAVEL FORMATION - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]
LOFT-DMTN LOWESTOFT FORMATION - DIAMICTON
GFDMP-XSV GLACIOFLUVIAL DEPOSITS, MID PLEISTOCENE - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]
STGR-XSV STANMORE GRAVEL FORMATION - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]
BSA-S BLOWN SAND - SAND [UNLITHIFIED DEPOSITS CODING SCHEME]
BTFU-SDSH BEACH AND TIDAL FLAT DEPOSITS (UNDIFFERENTIATED) - SEDIMENT, SHELL (SHELLS)
BTFU-XCZS BEACH AND TIDAL FLAT DEPOSITS (UNDIFFERENTIATED) - CLAY, SILT AND SAND [UNLITHIFIED DEPOSITS CODING SCHEME]
HEAD-XCZ HEAD - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]
HEAD-XCZSV HEAD - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]
MBD-SDSH MARINE BEACH DEPOSITS - SEDIMENT, SHELL (SHELLS)
RTD1-XCZ RIVER TERRACE DEPOSITS, 1 - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]
RTD1-XSV RIVER TERRACE DEPOSITS, 1 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]
RTD2-XCZ RIVER TERRACE DEPOSITS, 2 - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]
RTD2-XSV RIVER TERRACE DEPOSITS, 2 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]
RTD3-XCZ RIVER TERRACE DEPOSITS, 3 - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]
RTD3-XSV RIVER TERRACE DEPOSITS, 3 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]
RTD4-XSV RIVER TERRACE DEPOSITS, 4 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]
RTFD-XCZ RAISED TIDAL FLAT DEPOSITS - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]
SGAO-XSV SAND AND GRAVEL OF UNCERTAIN AGE AND ORIGIN - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]
T1T3-XCZ RIVER TERRACE DEPOSITS, 1 TO 3 - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]
T1T3-XSV RIVER TERRACE DEPOSITS, 1 TO 3 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]
T2T3-XSV RIVER TERRACE DEPOSITS, 2 TO 3 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]
ew258_259_southend_and_foulness_bedrock
LEX_RCS_I
BGS-SANDU BAGSHOT FORMATION - SAND
CLGB-CLSISA CLAYGATE MEMBER - CLAY, SILT AND SAND
LC-CLSISA LONDON CLAY FORMATION - CLAY, SILT AND SAND
TAB-SANDU THANET FORMATION - SAND
HWH-SAGR HARWICH FORMATION - SAND AND GRAVEL
LMBE-CLSISA LAMBETH GROUP - CLAY, SILT AND SAND
ew257_romford_superficial
LEX_RCS_I
ALV-CZPS ALLUVIUM - CLAY, SILTY, PEATY, SANDY [UNLITHIFIED DEPOSITS CODING SCHEME]
ALV-XCZSV ALLUVIUM - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]
TRD-XCZ TIDAL RIVER OR CREEK DEPOSITS - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]
KPGR-XSV KEMPTON PARK GRAVEL FORMATION - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]
ROSI-XCZ RODING SILT MEMBER - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]
HAGR-XSV HACKNEY GRAVEL MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]
ILSI-XCZ ILFORD SILT MEMBER - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]
LHGR-XSV LYNCH HILL GRAVEL MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]
TPGR-XSV TAPLOW GRAVEL FORMATION - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]
BHT-XSV BOYN HILL GRAVEL MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]
BPGR-XSV BLACK PARK GRAVEL MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]
LOFT-DMTN LOWESTOFT FORMATION - DIAMICTON
GFDMP-XSV GLACIOFLUVIAL DEPOSITS, MID PLEISTOCENE - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]
GLLMP-XCZS GLACIOLACUSTRINE DEPOSITS, MID PLEISTOCENE - CLAY, SILT AND SAND [UNLITHIFIED DEPOSITS CODING SCHEME]
WOGR-XSV WOODFORD GRAVEL FORMATION - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]
STGR-XSV STANMORE GRAVEL FORMATION - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]
HEAD-XCZSV HEAD - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]
PEAT-P PEAT - PEAT [UNLITHIFIED DEPOSITS CODING SCHEME]
RTDU-XSV RIVER TERRACE DEPOSITS (UNDIFFERENTIATED) - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]
SUPD-SED SUPERFICIAL DEPOSITS - SEDIMENT
ew257_romford_bedrock
LEX_RCS_I
BGS-SANDU BAGSHOT FORMATION - SAND
CLGB-CLSISA CLAYGATE MEMBER - CLAY, SILT AND SAND
CLGB-SANDU CLAYGATE MEMBER - SAND
LC-CLSISA LONDON CLAY FORMATION - CLAY, SILT AND SAND
TAB-SANDU THANET FORMATION - SAND
HWH-SAGR HARWICH FORMATION - SAND AND GRAVEL
LMBE-CLSISA LAMBETH GROUP - CLAY, SILT AND SAND
LSNCK-CHLK LEWES NODULAR CHALK FORMATION, SEAFORD CHALK FORMATION AND NEWHAVEN CHALK FORMATION (UNDIFFERENTIATED) - CHALK

there being only half a mile (0.8km) between the two sites (Chandler 1916, 242). It was thanks to gravel extraction that Worthington Smith's primary context site at Caddington was exposed (Smith 1894).

Table 9.5. Number of gravel and brick pits mapped onto each interfluve and to which Chalklands Lower-Middle Palaeolithic dataset entries are attributed.

Interfluve	Gravel pits	Brick pits
South Downs		
Eastbourne-Cuckmere	0	0
Cuckmere - Ouse	0	0
Ouse-Adur	2	0
Adur-Arun	0	0
Arun-Lavant	7	0
Lavant-Ems	0	0
Ems - Meon	1	0
Meon - Itchen	0	0
Itchen - Test	2	0
Totals	***12***	***0***
Chilterns		
Hitchin – Lilley Bottom	1	4
Lilley Bottom - Luton	4	6
Luton - Dunstable	11	4
Dunstable - Dagnall	4	1
Dagnall - Tring	0	0
Tring - Wendover	3	3
Wendover – Princes Risboro’	1	0
Princes Risboro’ - Goring	54	2
Totals	***78***	***20***
North Downs		
Folkestone – Great Stour	2	0
Great Stour - Medway	1	1
Medway - Darent	11	2
Darent - Merstham	8	7
Merstham - Mole	0	0
Mole - Wey	0	0
Wey – Blackwater Lodden	0	0
Totals	***22***	***10***

Urbanisation and infrastructure development

Variables I considered under this heading were infrastructure building - roads, canals, trenches for water, sewage and gas pipelines – as well as commercial and domestic building development. Railways are dealt with separately below. Whilst aggregate extraction provided the opportunity for early collectors to gain access to Pleistocene deposits, it also provided material for the building boom that would render many areas inaccessible to later archaeologists (Harris *et al.* 2019).

By comparison with the gravel and brickearth extraction industries, the impact on the archaeological record of rapid urbanisation during the late 19th/early 20th century was limited. Although 97 (5.5%) of my total dataset entries are attributable to urbanisation processes, only 59 (3.3%) of these lie on the Chalk footprint of an interfluve and 8 of the interfluves in my core study areas have no finds attributed to urbanisation and infrastructure development (Table 9.6). In most cases this is because the nearest town to each was still relatively small. Where that is not the case (Ems-Meon, Itchen-Test and Darent-Merstham) the nearest large towns (Portsmouth, Southampton and Croydon respectively), are not situated on the Chalk interfluves.

Victorian urbanisation created a huge demand for aggregates and brickmaking clay to deal with the unprecedented demand for housing and infrastructure in rapidly growing towns. This was further stimulated by the development of the railways, which led to a doubling and trebling of population in towns linked to the network. Between 1849 and 1901 for example, the population of Eastbourne rose from 3,015 to 43,300. During the same period, the population of London increased from about two million to five and a half million (White 1982; 1987).

The demand for aggregates, especially gravel for road and rail-building, led to an increase in its scale of extraction. The digging of trenches for public services, road construction and house-building associated with this massive urbanisation also revealed large sections of Pleistocene deposits, providing collecting opportunities for antiquarians. It was urbanisation – the building of houses in Stoke Newington - that first revealed his ‘floor’ to Worthington Smith. He records how he then visited and kept a record of the

Table 9.6 Chalklands Lower-Middle Palaeolithic dataset entries attributable to urbanisation

Interfluve	Chalk in 100km2	Population of nearest large town in 1901	Urbanisation	Dataset entries per 100km^2
South Downs				
Eastbourne-Cuckmere	0.66	43,300	0	0.00
Cuckmere - Ouse	0.80	11,000	0	0.00
Ouse-Adur	1.43	123,500	2	1.40
Adur-Arun	0.76	22,000	2	2.63
Arun-Lavant	3.74	22,000	1	0.27
Lavant-Ems	1.21	2,000	1	0.83
Ems - Meon	2.22	188,100	0	0.00
Meon - Itchen	1.74	20,900	0	0.00
Itchen - Test	2.20	104,800	0	0.00
Totals	***14.76***		***6***	***0.41***
Chilterns				
Hitchin – Lilley Bottom	1.67	10,000	1	0.60
Lilley Bottom - Luton	1.74	34,600	1	0.57
Luton - Dunstable	1.70	16,000	1	0.59
Dunstable - Dagnall	1.99	11,300	0	0.00
Dagnall - Tring	1.23	6,371	0	0.00
Tring - Wendover	3.12	7,245	7	2.24
Wendover – Princes Risboro’	2.03	22,700	6	2.96
Princes Risboro’ - Goring	5.72	72,200	15	2.62
Totals	***19.20***		***31***	***1.61***
North Downs				
Folkestone – Great Stour	5.21	41,800	3	0.58
Great Stour - Medway	3.82	42,500	3	0.79
Medway - Darent	2.77	27,200	8	2.89
Darent - Merstham	1.92	133,900	5	2.60
Merstham - Mole	1.71	7,670	2	1.17
Mole - Wey	0.66	15,900	1	1.52
Wey – Blackwater	0.12	8,748	0	0.00
Totals	***16.21***		***22***	***1.36***

These entries were not individually mapped onto the geology maps but were allocated to their interfluves from analysis of my site-lists. For total dataset entries attributed to urbanisation in each study area, including those off the Chalk footprint, see Table 6.2.
(Relates to Table 9.6 above).

exposed surface of every drain, house foundation and pit until he had established the floor's extern across three to four miles of north London (Smith 1894).

Evidence from the Hampshire Basin suggests that most collectors lived in major urban centres which, consequently, saw the greatest collecting activity (Hosfield 1998; 1999). However, Table 7.3 demonstrates that, while this may be true for an area dominated by very large towns such as Southampton and Portsmouth which are surrounded by rich gravel deposits, for the Chalk interfluves it was the opportunities presented by the presence or absence of aggregates/brickearth extraction which drove the Evidence from the Hampshire Basin suggests that most collectors lived in major urban centres which, consequently, saw the greatest collecting activity (Hosfield 1998; 1999). However, Table 7.3 demonstrates that, while this may be true for an area dominated by very large towns such as Southampton and Portsmouth which are surrounded by rich gravel deposits, for the Chalk interfluves it was the opportunities presented by the presence or absence of aggregates/brickearth extraction which drove thedevelopment of the archaeological record. Without the Chalk and gravel quarries in the Dartford/Gravesend area, the disproportionate size of London's population would have had little effect on the archaeology of the Lower Thames valley.

Railways

The development of the railway network in southeast England is described in Chapter Six. Only 17 (0.96%) of my British dataset entries can be attributed to railway construction and maintenance, which bypassed most of the Chalk interfluves. Dataset entries attributed to that construction are recorded for only five – Lilley Bottom to Luton, Tring to Wendover and Princes Risborough to Goring in the Chilterns; Great Stour to Medway and Medway to Darent on the North Downs (Table 9.7). Construction of the railway network had no direct impact on the archaeological record of the South Downs.

Table 9.7 Dataset entries attributable to railway construction

Interfluve	Chalk in 100km2	Railway construction	Dataset entries per 100km^2
South Downs			
Eastbourne-Cuckmere	0.66	0	0.00
Cuckmere - Ouse	0.80	0	0.00
Ouse-Adur	1.43	0	0.00
Adur-Arun	0.76	0	0.00
Arun-Lavant	3.74	0	0.00
Lavant-Ems	1.21	0	0.00
Ems - Meon	2.22	0	0.00
Meon - Itchen	1.74	0	0.00
Itchen - Test	2.20	0	0.00
Totals	***14.76***	***0***	***0.00***
Chilterns			
Hitchin – Lilley Bottom	1.67	0	0.00
Lilley Bottom - Luton	1.74	2	1.15
Luton - Dunstable	1.70	0	0.00
Dunstable - Dagnall	1.99	0	0.00
Dagnall - Tring	1.23	0	0.00
Tring - Wendover	3.12	1	0.32
Wendover – Princes Risboro'	2.03	0	0.00
Princes Risboro' - Goring	5.72	3	0.52
Totals	***19.20***	***6***	***0.31***
North Downs			
Folkestone – Great Stour	5.21	0	0.00
Great Stour - Medway	3.82	4	1.05
Medway - Darent	2.77	4	1.44
Darent - Merstham	1.92	0	0.00
Merstham - Mole	1.71	0	0.00
Mole - Wey	0.66	0	0.00
Wey – Blackwater Lodden	0.12	0	0.00
Totals	***16.21***	***8***	***0.49***

These Chalk upland dataset entries were not individually mapped onto the geology maps but were allocated to their interfluve by analysis of my site lists. (Relates to table 9.7 above).

All four of the dataset entries on the Medway-Darent interfluve are the result of work on the Channel Tunnel rail link and all four entries for the Great Stour - Medway interfluve were found during construction of a military railway. As on the South Downs, construction of the public railway network in the late 19th/early 20th century had no direct impact on the archaeological record of the North Downs. Only the six Chiltern discoveries were made during Victorian construction of the railway lines into and out of London.

Although the impact of railway construction on the archaeological record was indirect it should not be underestimated. It created a huge demand for aggregates, made large swathes of Pleistocene deposits accessible to antiquarian collectors and facilitated cheap travel to more distant quarries.

The development of the South Eastern Railway's north Kent lines between 1849 and 1895, for example, made it easy for collectors and geologists to reach the Chalk and brickearth quarries on the dipslope of the Lower Thames, including Barnfield Pit and Bakers Hole. The arrival of the railways also stimulated a huge growth in urbanisation, further increasing the demand for aggregates and the consequent exposure of Pleistocene deposits.

iv) Visualising the relationship between the scale of antiquarian collecting activities and findspot distribution.

As discussed in Chapter Two, several of the late 19th/early 20th century collectors made a substantial contribution to the contemporary debate about human antiquity, theorising about the nature of early humans and their behaviour. Like John Evans, Worthington George Smith was a linear evolutionist who identified three distinct tool classes from southern England, belonging to three distinct geological ages (O'Connor 2007). For Smith, early man was bestial, dirty and without proper speech (Smith 1894). Taking unilateral evolution even further, Benjamin Harrison was the father of the British Eolith debate, his eoliths from the North Downs plateau being central to the debate about Tertiary Man. Henry Stopes was another linear evolutionist and eolith supporter who believed the development of human mental capacities could be tracked through ever more sophisticated

manufacturing skills. F.C.J. Spurrell and Llewellyn Treacher, however, were cautious about using tool types and techniques as reliable time-markers.

The collections amassed by the large number of individual collectors between 1860 and 1960 account for ~78% of the handaxes and 85% of finds locations in the British Lower-Middle Palaeolithic record. These collections also provide details of sites that no longer exist or have been buried by urbanisation (Harris *et al.* 2019). Antiquarian collecting is thus a significant variable underpinning the archaeological record, but one for which frequently inadequate or non-existent documentation makes it difficult to reduce to quantifiable data. Nonetheless, its predominance in that record makes it crucial to our understanding of findspot distribution patterns.

Despite the large number of antiquarian collectors, only 40 collected 100 or more artefacts, between them contributing 90% of the record. They included Worthington George Smith and Llewellyn Treacher in the Chilterns and Benjamin Harrison on the North Downs. I therefore identified from my site lists the number of total dataset entries attributed to these three. I then calculated the percentage each had contributed of the finds from their local collecting areas. I also identified the entries attributable to antiquarian collecting in the Swanscombe-Greenhithe area (Maps 9.3, 9.4 and 9.5 show the results). As already stated, there were no comparable individual collectors on the Chalk of the South Downs.

The Chilterns

Worthington George Smith was the only significant antiquarian collector on the North Chilterns (here defined as being between the Hitchin to Lilley Bottom and Tring to Dagnall gaps). Operating from his home in Dunstable, Smith collected regularly within a six-mile radius of his home as well as sometimes travelling further afield in search of the sources of the gravels used for roads or in building works in which he had found worked flints. It was in tracking the source of gravel used on roads in Dunstable that Smith was led to the gravel pits at Caddington (Smith 1894, 93). He also acquired artefacts from other areas through the network of collectors of which he was a part. For example, he is included in Davis' (2013) list of collectors from the Solent area and in the SRPP data is listed as having found a deeply stained ovate implement from "Redbridge", Southampton. Smith

also discovered four primary context nationally significant Acheulean sites, three in the North Chilterns at Caddington, Gaddesden Row and Round Green Luton, the fourth in 1878 in Stoke Newington, London.

Thirty-three of my Chiltern dataset entries are attributable to Worthington Smith, out of a total of 158 entries on the Chalk footprint of the North Chilterns or 186 entries both on and off the Chalk. This means that Smith's finds equate to 20.8% of the former and 17.7% of the latter. By either reckoning, he made a substantial contribution to the archaeological record. Map 9.3, which shows Smith's findspots differentiated in blue, demonstrates his impact on the archaeological distribution maps of this area.

In the south Chilterns, the foremost collector was Llewellyn Treacher, who concentrated his activities on >50 gravel pits on the Thames dipslope in the Reading and Maidenhead areas around his home at Twyford. Map 9.4 shows Treacher's findspots differentiated in blue, with all others in red, likewise demonstrating his impact on the archaeological record in those areas. Comparison of the two maps also shows the difference in Clay-with-flints survival between the north and south Chilterns. Sixty-seven (17%) of my South Chiltern dataset entries are attributable to Llewellyn Treacher, with a further 15 entries (3.8%) attributable to G.W. Smith, a Caversham banker who also collected in the Reading area.

Treacher collected >500 handaxes from the 'super site' of Furze Platt (White *et al.* 2018) in the Maidenhead area. His concentration until late in his career on only the finest handaxes (Tyldesley 1986, 127) is an example of yet another collector bias being introduced into the archaeological record. Virtually all Treacher's finds were made within the Chalk footprint of the Princes Risborough-Goring interfluve, so are included in my calculations of total findspot entries per 100km^2 (38.6mi^2) of Chalk, although they lie predominantly on the Black Park, Winter Hill and Boyn Hill gravels of the river Thames at the base of the Chalk dipslope. Total Clay-with-flints survival on the Princes Risborough-Goring interfluve is relatively high at 15.56% but, as can be seen in Map 9.4, it is scattered and fragmentary. In addition, the very large number (54) of gravel pits on the interfluve are responsible for an enormous number of dataset entries.

The North Downs

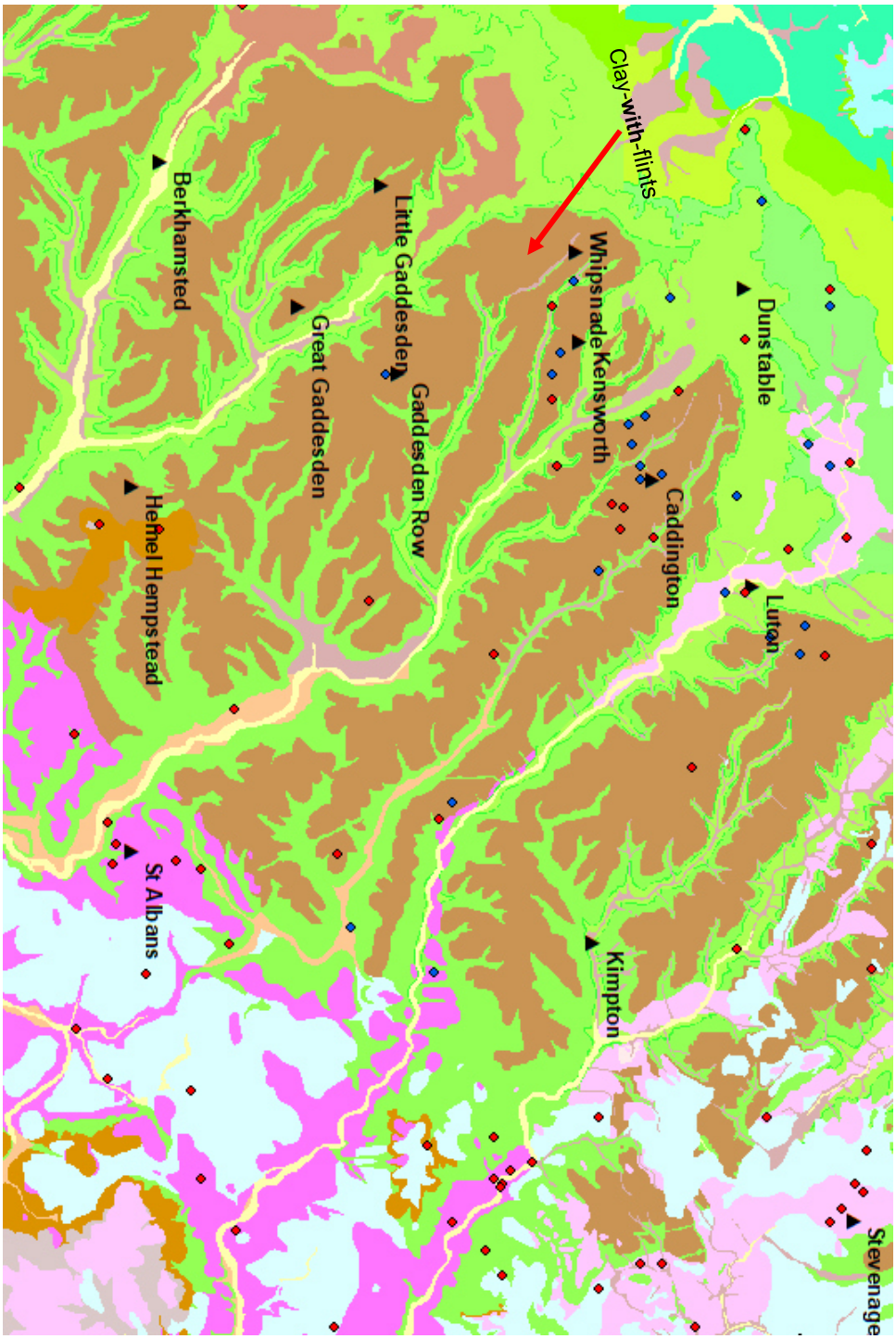
By far the most significant collector on the North Downs was Benjamin Harrison of Ightham. His reputation compromised by his involvement in the eolith controversy (*cf.* Chapter Two) Harrison is more appropriately remembered for finding on the North Downs plateau the first properly contextualised evidence of glacial and pre-glacial man in Britain (McNabb 2009).

Forty Harrison sites are included in my dataset, 33 of them relating to findspots on the Medway – Darent interfluve. Although constituting only 8.5% of my total Kent dataset, Harrison's sites translate into 22 (59.5%) plateau findspots on that interfluve, out of a total of 37. His collecting activities thus had a major impact on the archaeological distribution map of the area. Map 9.5, with Harrison's findspots marked in blue, demonstrates this impact. The 6-inch Ordnance Survey maps on which Harrison marked his findspots are now in the care of Maidstone Museum.

Ashton *et al.* (2015) have drawn attention to the potential for individual 'supersites' to skew the archaeological record owing to their dominance over a regional Palaeolithic record. Hosfield (1999; 2001) proposed a range of localised geomorphological processes that might have led to the accumulation of large numbers of artefacts in particular localities. Others have viewed such prolific sites as evidence of significant local human occupation (Roe 1981; Wymer 1999) or the exploitation of rich local raw material resources (Ashton and Hosfield 2010).

Map 9.5 shows the huge concentration of sites in the Swanscombe - Greenhithe area. They represent the cumulative collector bias introduced into the record by the activities of the multiple collectors drawn to the area because of the known richness of the quarries there. Henry Stopes, F.C.J. Spurrell, Henry Dewey, Reginald Smith, M.A.C. Hinton and A.S. Kennard all were attracted to the area and huge numbers of artefacts were collected from the gravel pits. Barnfield Pit, Swanscombe (incorporating the former Milton Street Pit) alone produced >1,300 handaxes, >85 roughouts, >180 cores, >460 retouched flakes and >475 unretouched flakes. Ashton and Hosfield (2010) defined 'super sites' as assemblages contributing at least 10% of the total handaxes from a study area. By that definition, Barnfield Pit may be regarded as a 'supersite' in its own right, as may Furze Platt,

Map 9.3 North Chilterns findspots, showing Worthington Smith's sites in blue. All other findspots are in red.



Geological Map Data BGS©UKRI 2019. For geology legend see following pages.

Geology Legend

- Smith findspots
- Findspots
- ▲ Towns

ew239_hertford_superficial

LEX_RCS_I

- ALV-XCZSV *ALLUVIUM - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
- ESI-XCZ *ENFIELD SILT MEMBER - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
- KPGR-XCZ *KEMPTON PARK GRAVEL FORMATION - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
- KPGR-XSV *KEMPTON PARK GRAVEL FORMATION - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
- TPGR-XSV *TAPLOW GRAVEL FORMATION - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
- LOFT-DMTN *LOWESTOFT FORMATION - DIAMICTON*
- WIHG-XSV *WINTER HILL GRAVEL - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
- DHGR-XSV *DOLLIS HILL GRAVEL MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
- GCGR-XSV *GERRARDS CROSS GRAVEL - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
- GFDMP-XSV *GLACIOFLUVIAL DEPOSITS, MID PLEISTOCENE - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
- GLLMP-XCZ *GLACIOLACUSTRINE DEPOSITS, MID PLEISTOCENE - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
- KGCA-XSV *KESGRAVE CATCHMENT SUBGROUP - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
- STGR-XSV *STANMORE GRAVEL FORMATION - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
- HEAD-XCZSV *HEAD - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
- HEAD-XVSZC *HEAD - GRAVEL, SAND, SILT AND CLAY [UNLITHIFIED DEPOSITS CODING SCHEME]*
- RTDU-XSV *RIVER TERRACE DEPOSITS (UNDIFFERENTIATED) - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
- SGAO-XSV *SAND AND GRAVEL OF UNCERTAIN AGE AND ORIGIN - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
- CWF-XCZSV *CLAY-WITH-FLINTS FORMATION - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*

ew238_aylesbury_superficial

LEX_RCS_I

- ALV-XCZSV *ALLUVIUM - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
- LOFT-DMTN *LOWESTOFT FORMATION - DIAMICTON*
- GCGR-XSV *GERRARDS CROSS GRAVEL - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
- GFDMP-XSV *GLACIOFLUVIAL DEPOSITS, MID PLEISTOCENE - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
- CWGR-XSV *CHORLEYWOOD GRAVEL FORMATION - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
- KGCA-XSV *KESGRAVE CATCHMENT SUBGROUP - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
- PRSG-XSV *PRINCES RISBOROUGH SAND AND GRAVEL - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
- HEAD-V *HEAD - GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
- HEAD-XCZ *HEAD - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
- HEAD-XCZSV *HEAD - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
- HEAD1-XCZSV *HEAD, 1 - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
- RTD1-XSV *RIVER TERRACE DEPOSITS, 1 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
- RTD2-XSV *RIVER TERRACE DEPOSITS, 2 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
- RTDU-XSV *RIVER TERRACE DEPOSITS (UNDIFFERENTIATED) - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
- CWF-XCZSV *CLAY-WITH-FLINTS FORMATION - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*

ew238_aylesbury_bedrock

LEX_RCS_I

- LC-CLSISA *LONDON CLAY FORMATION - CLAY, SILT AND SAND*
- LMBE-CLSISA *LAMBETH GROUP - CLAY, SILT AND SAND*
- CKR-CHLK *CHALK ROCK MEMBER - CHALK*
- LECH-CHLK *LEWES NODULAR CHALK FORMATION - CHALK*
- LESE-CHLK *LEWES NODULAR CHALK FORMATION AND SEAFORD CHALK FORMATION (UNDIFFERENTIATED) - CHALK*
- NPCH-CHLK *NEW PIT CHALK FORMATION - CHALK*
- GLML-GLSST *GLAUCONITIC MARL MEMBER - SANDSTONE, GLAUCONITIC*
- HNCK-CHLK *HOLYWELL NODULAR CHALK FORMATION AND NEW PIT CHALK FORMATION (UNDIFFERENTIATED) - CHALK*
- MR-CHLK *MELBOURN ROCK MEMBER - CHALK*
- WZCK-CHLK *WEST MELBURY MARLY CHALK FORMATION AND ZIG ZAG CHALK FORMATION (UNDIFFERENTIATED) - CHALK*
- ZZCH-CHLK *ZIG ZAG CHALK FORMATION - CHALK*
- GLT-MDST *GAULT FORMATION - MUDSTONE*
- GUGS-MDSS *GAULT FORMATION AND UPPER GREENSAND FORMATION (UNDIFFERENTIATED) - MUDSTONE, SILTSTONE AND SANDSTONE*
- UGS-SISD *UPPER GREENSAND FORMATION - SILTSTONE AND SANDSTONE*
- PB-LMAR *PURBECK GROUP - LIMESTONE AND [SUBEQUAL/SUBORDINATE] ARGILLACEOUS ROCKS, INTERBEDDED*
- PL-LMCS *PORTLAND GROUP - LIMESTONE AND CALCAREOUS SANDSTONE*
- POSA-LMCS *PORTLAND SAND FORMATION - LIMESTONE AND CALCAREOUS SANDSTONE*
- POST-LMST *PORTLAND STONE FORMATION - LIMESTONE*
- KC-MDST *KIMMERIDGE CLAY FORMATION - MUDSTONE*

ew220_leighton_buzzard_superficial

LEX_RCS_I

ALV-XCZSV	*ALLUVIUM - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
T1T2-XSV	*RIVER TERRACE DEPOSITS, 1 TO 2 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
LOFT-DMTN	*LOWESTOFT FORMATION - DIAMICTON*
ODT-DMTN	*OADBY MEMBER - DIAMICTON*
GFDMP-XSV	*GLACIOFLUVIAL DEPOSITS, MID PLEISTOCENE - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
GLLMP-XCZ	*GLACIOLACUSTRINE DEPOSITS, MID PLEISTOCENE - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
FELM-XSV	*FELMERSHAM MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
STGO-XSV	*STOKE GOLDINGTON MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XCZSV	*HEAD - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XVSZC	*HEAD - GRAVEL, SAND, SILT AND CLAY [UNLITHIFIED DEPOSITS CODING SCHEME]*
PEAT-P	*PEAT - PEAT [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD1-XSV	*RIVER TERRACE DEPOSITS, 1 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD2-XSV	*RIVER TERRACE DEPOSITS, 2 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
SGAO-XSV	*SAND AND GRAVEL OF UNCERTAIN AGE AND ORIGIN - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
CWF-XCZSV	*CLAY-WITH-FLINTS FORMATION - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
SUPNM-UKNOWN	*SUPERFICIAL THEME NOT MAPPED [FOR DIGITAL MAP USE ONLY] - UNKNOWN/UNCLASSIFIED ENTRY*

ew220_leighton_buzzard_bedrock

LEX_RCS_I

CKR-CHLK	*CHALK ROCK MEMBER - CHALK*
LESE-CHLK	*LEWES NODULAR CHALK FORMATION AND SEAFORD CHALK FORMATION (UNDIFFERENTIATED) - CHALK*
TRK-CHLK	*TOP ROCK BED - CHALK*
HNCK-CHLK	*HOLYWELL NODULAR CHALK FORMATION AND NEW PIT CHALK FORMATION (UNDIFFERENTIATED) - CHALK*
MR-CHLK	*MELBOURN ROCK MEMBER - CHALK*
TTST-CHLK	*TOTTERNHOE STONE MEMBER - CHALK*
WMCH-CHLK	*WEST MELBURY MARLY CHALK FORMATION - CHALK*
WMCH-LMST	*WEST MELBURY MARLY CHALK FORMATION - LIMESTONE*
ZZCH-CHLK	*ZIG ZAG CHALK FORMATION - CHALK*
GLT-MDST	*GAULT FORMATION - MUDSTONE*
UGS-SIMD	*UPPER GREENSAND FORMATION - SILTSTONE AND MUDSTONE, INTERBEDDED*
WBS-SDST	*WOBURN SANDS FORMATION - SANDSTONE*
WBS-SMCCST	*WOBURN SANDS FORMATION - SMECTITE-CLAYSTONE*
PB-SDLM	*PURBECK GROUP - SANDSTONE AND [SUBEQUAL/SUBORDINATE] LIMESTONE, INTERBEDDED*
PL-LMCS	*PORTLAND GROUP - LIMESTONE AND CALCAREOUS SANDSTONE*
POSA-CALSST	*PORTLAND SAND FORMATION - SANDSTONE, CALCAREOUS*
KC-MDST	*KIMMERIDGE CLAY FORMATION - MUDSTONE*
WEY-MDST	*WEYMOUTH MEMBER - MUDSTONE*
WWAC-MDST	*WEST WALTON FORMATION AND AMPTHILL CLAY FORMATION (UNDIFFERENTIATED) - MUDSTONE*
KLB-SDSM	*KELLAWAYS FORMATION - SANDSTONE, SILTSTONE AND MUDSTONE*
OXC-MDST	*OXFORD CLAY FORMATION - MUDSTONE*
PET-MDST	*PETERBOROUGH MEMBER - MUDSTONE*
SBY-MDST	*STEWARTBY MEMBER - MUDSTONE*
STWE-MDST	*STEWARTBY MEMBER AND WEYMOUTH MEMBER (UNDIFFERENTIATED) - MUDSTONE*

ew221_hitchin_superficial

LEX_RCS_I

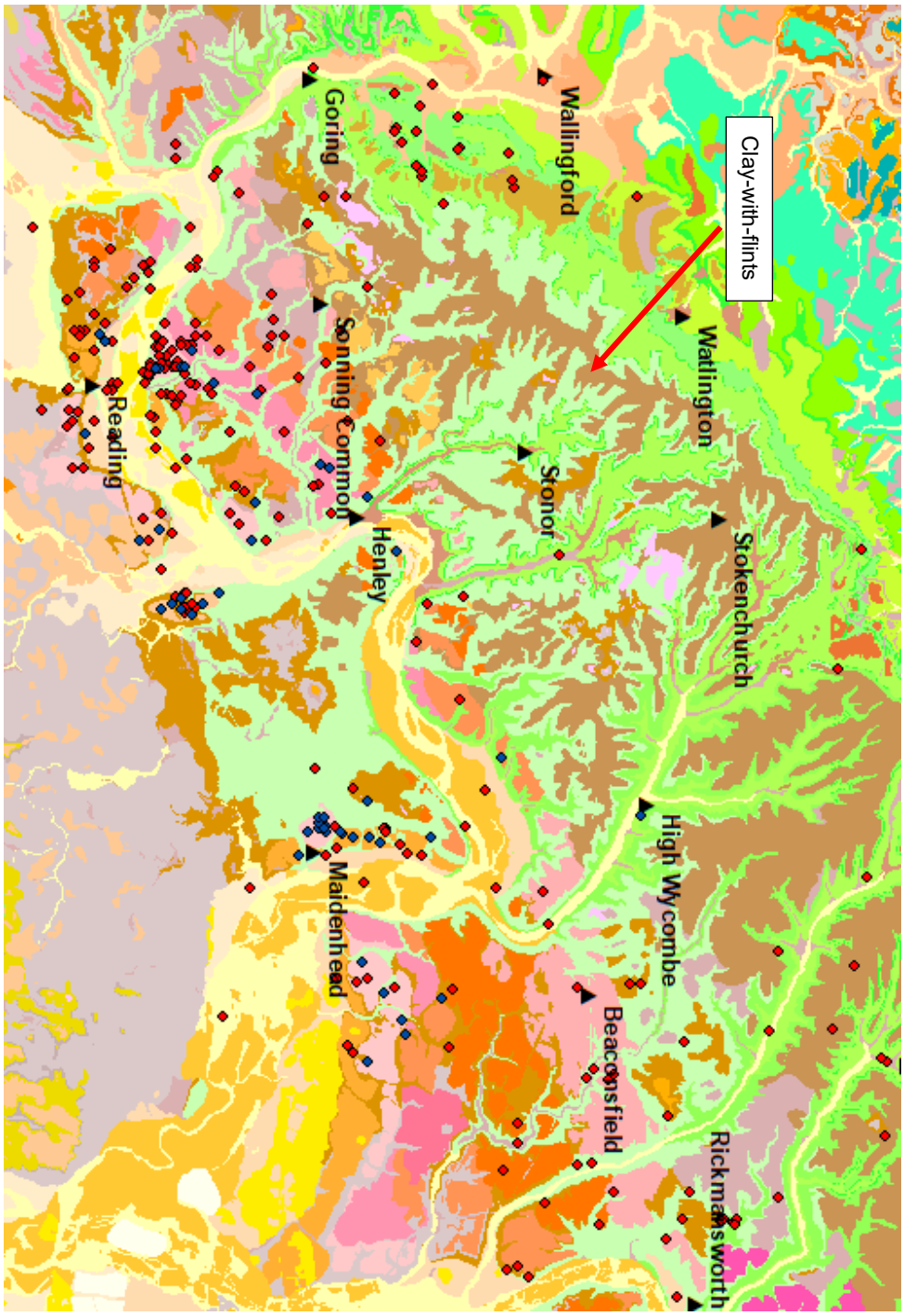
	ALV-XCZSV	*ALLUVIUM - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
	LOFT-DMRC	*LOWESTOFT FORMATION - DIAMICTON WITH CHALK RAFTS*
	LOFT-DMTN	*LOWESTOFT FORMATION - DIAMICTON*
	ODT-DMTN	*OADBY MEMBER - DIAMICTON*
	GFDMP-XSV	*GLACIOFLUVIAL DEPOSITS, MID PLEISTOCENE - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
	GLLMP-XCZ	*GLACIOLACUSTRINE DEPOSITS, MID PLEISTOCENE - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
	KGCA-XSV	*KESGRAVE CATCHMENT SUBGROUP - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
	LTH-XSV	*LETCHWORTH GRAVELS FORMATION - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
	ALF-XSZ	*ALLUVIAL FAN DEPOSITS - SAND AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
E	HEAD-XCZSV	*HEAD - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
	HEAD-XVSZC	*HEAD - GRAVEL, SAND, SILT AND CLAY [UNLITHIFIED DEPOSITS CODING SCHEME]*
	PEAT-P	*PEAT - PEAT [UNLITHIFIED DEPOSITS CODING SCHEME]*
	RTD1-XSV	*RIVER TERRACE DEPOSITS, 1 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
	RTDU-XSV	*RIVER TERRACE DEPOSITS (UNDIFFERENTIATED) - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
	CWF-XCZSV	*CLAY-WITH-FLINTS FORMATION - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
	SUPNM-UKNOWN	*SUPERFICIAL THEME NOT MAPPED [FOR DIGITAL MAP USE ONLY] - UNKNOWN/UNCLASSIFIED ENTRY*

ew221_hitchin_bedrock

LEX_RCS_I

LC-CLSISA	*LONDON CLAY FORMATION - CLAY, SILT AND SAND*
LMBE-CLSISA	*LAMBETH GROUP - CLAY, SILT AND SAND*
CKR-CHLK	*CHALK ROCK MEMBER - CHALK*
LESE-CHLK	*LEWES NODULAR CHALK FORMATION AND SEAFORD CHALK FORMATION (UNDIFFERENTIATED) - CHALK*
NPCH-CHLK	*NEW PIT CHALK FORMATION - CHALK*
TRK-CHLK	*TOP ROCK BED - CHALK*
HCK-CHLK	*HOLYWELL NODULAR CHALK FORMATION - CHALK*
HNCK-CHLK	*HOLYWELL NODULAR CHALK FORMATION AND NEW PIT CHALK FORMATION (UNDIFFERENTIATED) - CHALK*
MR-CHLK	*MELBOURN ROCK MEMBER - CHALK*
TTST-CHLK	*TOTTERNHOE STONE MEMBER - CHALK*
WMCH-CHLK	*WEST MELBURY MARLY CHALK FORMATION - CHALK*
ZZCH-CHLK	*ZIG ZAG CHALK FORMATION - CHALK*
GLT-MDST	*GAULT FORMATION - MUDSTONE*
WBS-SDST	*WOBURN SANDS FORMATION - SANDSTONE*

Map 9.4 South Chilterns findspots, showing Llewellyn Treacher's sites in blue. All other findspots are in red.



(Map Data BGS©UKRI 2019). For geology legend see following pages.

Legend

- Treacher findspots
- Findspots
- ▲ Towns

ew269_windsor_superficial

LEX_RCS_I

ALV-XCZSV	*ALLUVIUM - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
KPGR-XSV	*KEMPTON PARK GRAVEL FORMATION - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
LASI-XCZ	*LANGLEY SILT MEMBER - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
SHGR-XSV	*SHEPPERTON GRAVEL MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
LHGR-XSV	*LYNCH HILL GRAVEL MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
TPGR-XSV	*TAPLOW GRAVEL FORMATION - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
BHT-XSV	*BOYN HILL GRAVEL MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
SUHG-XSV	*SURREY HILL GRAVEL MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
ALV1-XCZSV	*ALLUVIUM 1 - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XCZSV	*HEAD - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XSV	*HEAD - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
PEAT-P	*PEAT - PEAT [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD2-XSV	*RIVER TERRACE DEPOSITS, 2 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD4-XSV	*RIVER TERRACE DEPOSITS, 4 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD5-XSV	*RIVER TERRACE DEPOSITS, 5 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD6-XSV	*RIVER TERRACE DEPOSITS, 6 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD7-XSV	*RIVER TERRACE DEPOSITS, 7 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD8-XSV	*RIVER TERRACE DEPOSITS, 8 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTDU-XSV	*RIVER TERRACE DEPOSITS (UNDIFFERENTIATED) - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
SGAO-XSV	*SAND AND GRAVEL OF UNCERTAIN AGE AND ORIGIN - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME*
SUPNM-WATR	*SUPERFICIAL THEME NOT MAPPED [FOR DIGITAL MAP USE ONLY] - WATER, TYPE UNSPECIFIED*

ew269_windsor_bedrock

LEX_RCS_I

BGS-SANDU	*BAGSHOT FORMATION - SAND*
CLGB-SSCL	*CLAYGATE MEMBER - SAND, SILT AND CLAY*
CMBS-SANDU	*CAMBERLEY SAND FORMATION - SAND*
LC-CLSISA	*LONDON CLAY FORMATION - CLAY, SILT AND SAND*
SAHP-GRAV	*ST ANN'S HILL PEBBLE BED MEMBER - GRAVEL*
STHP-GRAV	*STANNERS HILL PEBBLE BED MEMBER - GRAVEL*
SWCL-CLAY	*SWINLEY CLAY MEMBER - CLAY*
WIDS-SSCL	*WINDLESHAM FORMATION - SAND, SILT AND CLAY*
LMBE-CLSISA	*LAMBETH GROUP - CLAY, SILT AND SAND*
SNCK-CHLK	*SEAFORD CHALK FORMATION AND NEWHAVEN CHALK FORMATION (UNDIFFERENTIATED) - CHALK*

ew268_reading_superficial

LEX_RCS_I

ALV-XCZSV	*ALLUVIUM - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
T1T2-XSV	*RIVER TERRACE DEPOSITS, 1 TO 2 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
BGGR-XSV	*BEENHAM GRANGE GRAVEL MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
KPGR-XSV	*KEMPTON PARK GRAVEL FORMATION - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
LASI-XCZ	*LANGLEY SILT MEMBER - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
LHGR-XSV	*LYNCH HILL GRAVEL MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
THGR-XSV	*THATCHAM GRAVEL - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
TPGR-XSV	*TAPLOW GRAVEL FORMATION - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
BHT-XSV	*BOYN HILL GRAVEL MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
BPGR-XSV	*BLACK PARK GRAVEL MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
BSGR-XSV	*BEENHAM STOCKS GRAVEL MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
SIGR-XSV	*SILCHESTER GRAVEL MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
WIHG-XSV	*WINTER HILL GRAVEL - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
GCGR-XSV	*GERRARDS CROSS GRAVEL - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
BDGR-XSV	*BEACONSFIELD GRAVEL - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
BYGR-XSV	*BUCKLEBURY COMMON GRAVEL MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
NO-XSV	*NORTHMOOR SAND AND GRAVEL MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
WGGR-XSV	*WESTLAND GREEN GRAVEL - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
BRK-XCZS	*BRICKEARTH - CLAY, SILT AND SAND [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XCZSV	*HEAD - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XVSZC	*HEAD - GRAVEL, SAND, SILT AND CLAY [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD1-XCZSV	*HEAD, 1 - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD1-XSV	*RIVER TERRACE DEPOSITS, 1 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD2-XSV	*RIVER TERRACE DEPOSITS, 2 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD3-XSV	*RIVER TERRACE DEPOSITS, 3 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD4-XSV	*RIVER TERRACE DEPOSITS, 4 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD5-XSV	*RIVER TERRACE DEPOSITS, 5 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD6-XSV	*RIVER TERRACE DEPOSITS, 6 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD7-XSV	*RIVER TERRACE DEPOSITS, 7 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD8-XSV	*RIVER TERRACE DEPOSITS, 8 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTDU-XSV	*RIVER TERRACE DEPOSITS (UNDIFFERENTIATED) - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
CWF-XCZSV	*CLAY-WITH-FLINTS FORMATION - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*

ew268_reading_bedrock

LEX_RCS_I

BGS-SANDU	*BAGSHOT FORMATION - SAND*
CMBS-SANDU	*CAMBERLEY SAND FORMATION - SAND*
LC-CLSISA	*LONDON CLAY FORMATION - CLAY, SILT AND SAND*
LC-SANDU	*LONDON CLAY FORMATION - SAND*
WIDS-SSCL	*WINDLESHAM FORMATION - SAND, SILT AND CLAY*
LMBE-CLSISA	*LAMBETH GROUP - CLAY, SILT AND SAND*
SECK-CHLK	*SEAFORD CHALK FORMATION - CHALK*
SNCK-CHLK	*SEAFORD CHALK FORMATION AND NEWHAVEN CHALK FORMATION (UNDIFFERENTIATED) - CHALK*
CKR-CHLK	*CHALK ROCK MEMBER - CHALK*
LECH-CHLK	*LEWES NODULAR CHALK FORMATION - CHALK*
NPCH-CHLK	*NEW PIT CHALK FORMATION - CHALK*
HCK-CHLK	*HOLYWELL NODULAR CHALK FORMATION - CHALK*
HNCK-CHLK	*HOLYWELL NODULAR CHALK FORMATION AND NEW PIT CHALK FORMATION (UNDIFFERENTIATED) - CHALK*
MR-CHLK	*MELBOURN ROCK MEMBER - CHALK*
ZZCH-CHLK	*ZIG ZAG CHALK FORMATION - CHALK*

ew255_beaconsfield_superficial

LEX_RCS_I

ALV-XCZSV	*ALLUVIUM - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
LASI-XCZ	*LANGLEY SILT MEMBER - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
SHGR-XSV	*SHEPPERTON GRAVEL MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
LHGR-XSV	*LYNCH HILL GRAVEL MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
TPGR-XSV	*TAPLOW GRAVEL FORMATION - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
BHT-XSV	*BOYN HILL GRAVEL MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
BPGR-XSV	*BLACK PARK GRAVEL MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
WHGLD-XSV	*WINTER HILL GRAVEL (LACUSTRINE DEPOSITS) - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
WIHG-XSV	*WINTER HILL GRAVEL - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
GCGR-XSV	*GERRARDS CROSS GRAVEL - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
BDGR-XSV	*BEACONSFIELD GRAVEL - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
CWGR-XSV	*CHORLEYWOOD GRAVEL FORMATION - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
STGR-XSV	*STANMORE GRAVEL FORMATION - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
WGGR-XSV	*WESTLAND GREEN GRAVEL - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
ALV1-XCZSV	*ALLUVIUM 1 - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-V	*HEAD - GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XCZ	*HEAD - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
SGAO-XSV	*SAND AND GRAVEL OF UNCERTAIN AGE AND ORIGIN - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
CWF-XCZSV	*CLAY-WITH-FLINTS FORMATION - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*

ew255_beaconsfield_bedrock

LEX_RCS_I

LC-CLSISA	*LONDON CLAY FORMATION - CLAY, SILT AND SAND*
LMBE-CLSISA	*LAMBETH GROUP - CLAY, SILT AND SAND*
SNCK-CHLK	*SEAFORD CHALK FORMATION AND NEWHAVEN CHALK FORMATION (UNDIFFERENTIATED) - CHALK*
LECH-CHLK	*LEWES NODULAR CHALK FORMATION - CHALK*
NPCH-CHLK	*NEW PIT CHALK FORMATION - CHALK*
HCK-CHLK	*HOLYWELL NODULAR CHALK FORMATION - CHALK*

ew254_henley_superficial

LEX_RCS_I

ALV-XCZSV	*ALLUVIUM - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
KPGR-XSV	*KEMPTON PARK GRAVEL FORMATION - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
SHGR-XSV	*SHEPPERTON GRAVEL MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
LHGR-XSV	*LYNCH HILL GRAVEL MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
TPGR-XSV	*TAPLOW GRAVEL FORMATION - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
BHT-XSV	*BOYN HILL GRAVEL MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
BPGR-XSV	*BLACK PARK GRAVEL MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
WIHG-XSV	*WINTER HILL GRAVEL - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
GCGR-XSV	*GERRARDS CROSS GRAVEL - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
BDGR-XSV	*BEACONSFIELD GRAVEL - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
HAN-XSV	*HANBOROUGH GRAVEL MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
NO-XSV	*NORTHMOOR SAND AND GRAVEL MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
PRSG-XSV	*PRINCES RISBOROUGH SAND AND GRAVEL - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
SURA-XSV	*SUMMERTOWN-RADLEY SAND AND GRAVEL MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
SWGR-XSV	*SATWELL GRAVEL FORMATION - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
WGGR-XSV	*WESTLAND GREEN GRAVEL - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
WV-XSV	*WOLVERCOTE SAND AND GRAVEL MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-V	*HEAD - GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-VC	*HEAD - GRAVEL, CLAYEY [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XCZSV	*HEAD - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XVSZC	*HEAD - GRAVEL, SAND, SILT AND CLAY [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD1-XCZSV	*HEAD, 1 - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD2-XCZSV	*HEAD, 2 - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
NO1A-XSV	*NORTHMOOR SAND AND GRAVEL MEMBER, LOWER FACET - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
NO1B-XSV	*NORTHMOOR SAND AND GRAVEL MEMBER, UPPER FACET - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD1-XSV	*RIVER TERRACE DEPOSITS, 1 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD2-XSV	*RIVER TERRACE DEPOSITS, 2 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD3-XSV	*RIVER TERRACE DEPOSITS, 3 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD5-XSV	*RIVER TERRACE DEPOSITS, 5 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD5A-XSV	*RIVER TERRACE DEPOSITS, 5A - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD5B-XSV	*RIVER TERRACE DEPOSITS, 5B - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD5C-XSV	*RIVER TERRACE DEPOSITS, 5C - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD6-XSV	*RIVER TERRACE DEPOSITS, 6 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD7-XSV	*RIVER TERRACE DEPOSITS, 7 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTDU-XSV	*RIVER TERRACE DEPOSITS (UNDIFFERENTIATED) - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
SGAO-XSV	*SAND AND GRAVEL OF UNCERTAIN AGE AND ORIGIN - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
TUFA-CATUFA	*TUFA - TUFA, CALCAREOUS*
CWF-S	*CLAY-WITH-FLINTS FORMATION - SAND [UNLITHIFIED DEPOSITS CODING SCHEME]*
CWF-XCZSV	*CLAY-WITH-FLINTS FORMATION - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*

ew254_henley_bedrock

LEX_RCS_I

LC-CLSISA	*LONDON CLAY FORMATION - CLAY, SILT AND SAND*
LMBE-CLSISA	*LAMBETH GROUP - CLAY, SILT AND SAND*
SECK-CHLK	*SEAFORD CHALK FORMATION - CHALK*
CKR-CHLK	*CHALK ROCK MEMBER - CHALK*
LECH-CHLK	*LEWES NODULAR CHALK FORMATION - CHALK*
LSNCK-CHLK	*LEWES NODULAR CHALK FORMATION, SEAFORD CHALK FORMATION AND NEWHAVEN CHALK FORMATION (UNDIFFERENTIATEI*
NPCH-CHLK	*NEW PIT CHALK FORMATION - CHALK*
GLML-GLSST	*GLAUCONITIC MARL MEMBER - SANDSTONE, GLAUCONITIC*
HCK-CHLK	*HOLYWELL NODULAR CHALK FORMATION - CHALK*
HNCK-CHLK	*HOLYWELL NODULAR CHALK FORMATION AND NEW PIT CHALK FORMATION (UNDIFFERENTIATED) - CHALK*
MR-CHLK	*MELBOURN ROCK MEMBER - CHALK*
TTST-CHLK	*TOTTERNHOE STONE MEMBER - CHALK*
WMCH-CHLK	*WEST MELBURY MARLY CHALK FORMATION - CHALK*
ZZCH-CHLK	*ZIG ZAG CHALK FORMATION - CHALK*
GLT-MDST	*GAULT FORMATION - MUDSTONE*
UGS-SISD	*UPPER GREENSAND FORMATION - SILTSTONE AND SANDSTONE*
LGS-SDST	*LOWER GREENSAND GROUP - SANDSTONE*
PL-LMCS	*PORTLAND GROUP - LIMESTONE AND CALCAREOUS SANDSTONE*
KC-MDST	*KIMMERIDGE CLAY FORMATION - MUDSTONE*
KC-SISD	*KIMMERIDGE CLAY FORMATION - SILTSTONE AND SANDSTONE*
AMKC-MDST	*AMPTHILL CLAY FORMATION AND KIMMERIDGE CLAY FORMATION (UNDIFFERENTIATED) - MUDSTONE*
KTON-SDST	*KINGSTON FORMATION - SANDSTONE*
LITC-LSMD	*LITTLEMORE MEMBER - LIMESTONE AND MUDSTONE, INTERBEDDED*

ew238_aylesbury_superficial

LEX_RCS_I

ALV-XCZSV	*ALLUVIUM - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
LOFT-DMTN	*LOWESTOFT FORMATION - DIAMICTON*
GCGR-XSV	*GERRARDS CROSS GRAVEL - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
GFDMP-XSV	*GLACIOFLUVIAL DEPOSITS, MID PLEISTOCENE - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
CWGR-XSV	*CHORLEYWOOD GRAVEL FORMATION - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
KGCA-XSV	*KESGRAVE CATCHMENT SUBGROUP - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
PRSG-XSV	*PRINCES RISBOROUGH SAND AND GRAVEL - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-V	*HEAD - GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XCZ	*HEAD - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XCZSV	*HEAD - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD1-XCZSV	*HEAD, 1 - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD1-XSV	*RIVER TERRACE DEPOSITS, 1 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD2-XSV	*RIVER TERRACE DEPOSITS, 2 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTDU-XSV	*RIVER TERRACE DEPOSITS (UNDIFFERENTIATED) - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
CWF-XCZSV	*CLAY-WITH-FLINTS FORMATION - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*

ew238_aylesbury_bedrock

LEX_RCS_I

LC-CLSISA	*LONDON CLAY FORMATION - CLAY, SILT AND SAND*
LMBE-CLSISA	*LAMBETH GROUP - CLAY, SILT AND SAND*
CKR-CHLK	*CHALK ROCK MEMBER - CHALK*
LECH-CHLK	*LEWES NODULAR CHALK FORMATION - CHALK*
LESE-CHLK	*LEWES NODULAR CHALK FORMATION AND SEAFORD CHALK FORMATION (UNDIFFERENTIATED) - CHALK*
NPCH-CHLK	*NEW PIT CHALK FORMATION - CHALK*
GLML-GLSST	*GLAUCONITIC MARL MEMBER - SANDSTONE, GLAUCONITIC*
HNCK-CHLK	*HOLYWELL NODULAR CHALK FORMATION AND NEW PIT CHALK FORMATION (UNDIFFERENTIATED) - CHALK*
MR-CHLK	*MELBOURN ROCK MEMBER - CHALK*
WZCK-CHLK	*WEST MELBURY MARLY CHALK FORMATION AND ZIG ZAG CHALK FORMATION (UNDIFFERENTIATED) - CHALK*
ZZCH-CHLK	*ZIG ZAG CHALK FORMATION - CHALK*
GLT-MDST	*GAULT FORMATION - MUDSTONE*
GUGS-MDSS	*GAULT FORMATION AND UPPER GREENSAND FORMATION (UNDIFFERENTIATED) - MUDSTONE, SILTSTONE AND SANDSTONE*
UGS-SISD	*UPPER GREENSAND FORMATION - SILTSTONE AND SANDSTONE*
PB-LMAR	*PURBECK GROUP - LIMESTONE AND [SUBEQUAL/SUBORDINATE] ARGILLACEOUS ROCKS, INTERBEDDED*
PL-LMCS	*PORTLAND GROUP - LIMESTONE AND CALCAREOUS SANDSTONE*
POSA-LMCS	*PORTLAND SAND FORMATION - LIMESTONE AND CALCAREOUS SANDSTONE*
POST-LMST	*PORTLAND STONE FORMATION - LIMESTONE*
KC-MDST	*KIMMERIDGE CLAY FORMATION - MUDSTONE*

ew237_thame_superficial

LEX_RCS_I

ALV-XCZSV	*ALLUVIUM - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
T3T4-XSV	*RIVER TERRACE DEPOSITS, 3 TO 4 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
GFDMP-XSV	*GLACIOFLUVIAL DEPOSITS, MID PLEISTOCENE - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
TILMP-DMTN	*TILL, MID PLEISTOCENE - DIAMICTON*
NO-XSV	*NORTHMOOR SAND AND GRAVEL MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
PRSG-XSV	*PRINCES RISBOROUGH SAND AND GRAVEL - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
SURA-XSV	*SUMMERTOWN-RADLEY SAND AND GRAVEL MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
WV-XSV	*WOLVERCOTE SAND AND GRAVEL MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XCZSV	*HEAD - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
NO1A-XSV	*NORTHMOOR SAND AND GRAVEL MEMBER, LOWER FACET - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
NO1B-XSV	*NORTHMOOR SAND AND GRAVEL MEMBER, UPPER FACET - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
PEAT-P	*PEAT - PEAT [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD1-XSV	*RIVER TERRACE DEPOSITS, 1 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD2-XSV	*RIVER TERRACE DEPOSITS, 2 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD3-XSV	*RIVER TERRACE DEPOSITS, 3 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD4-XSV	*RIVER TERRACE DEPOSITS, 4 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD5-XSV	*RIVER TERRACE DEPOSITS, 5 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD6-XSV	*RIVER TERRACE DEPOSITS, 6 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD7-XSV	*RIVER TERRACE DEPOSITS, 7 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
TUFA-CATUFA	*TUFA - TUFA, CALCAREOUS*
CWF-XCZSV	*CLAY-WITH-FLINTS FORMATION - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
SUPNM-WATR	*SUPERFICIAL THEME NOT MAPPED [FOR DIGITAL MAP USE ONLY] - WATER, TYPE UNSPECIFIED*

ew237_thame_bedrock

LEX_RCS_I

	CKR-CHLK	*CHALK ROCK MEMBER - CHALK*
	LECH-CHLK	*LEWES NODULAR CHALK FORMATION - CHALK*
	GLML-GLSST	*GLAUCONITIC MARL MEMBER - SANDSTONE, GLAUCONITIC*
	HNCK-CHLK	*HOLYWELL NODULAR CHALK FORMATION AND NEW PIT CHALK FORMATION (UNDIFFERENTIATED) - CHALK*
	MR-CHLK	*MELBOURN ROCK MEMBER - CHALK*
	TTST-CHLK	*TOTTERNHOE STONE MEMBER - CHALK*
	WMCH-CHLK	*WEST MELBURY MARLY CHALK FORMATION - CHALK*
	ZZCH-CHLK	*ZIG ZAG CHALK FORMATION - CHALK*
	GLT-MDST	*GAULT FORMATION - MUDSTONE*
	UGS-SISD	*UPPER GREENSAND FORMATION - SILTSTONE AND SANDSTONE*
	LGS-SDST	*LOWER GREENSAND GROUP - SANDSTONE*
	WHS-MDST	*WHITCHURCH SAND FORMATION - MUDSTONE*
	WHS-SDST	*WHITCHURCH SAND FORMATION - SANDSTONE*
K	PB-LMAR	*PURBECK GROUP - LIMESTONE AND [SUBEQUAL/SUBORDINATE] ARGILLACEOUS ROCKS, INTERBEDDED*
	PL-LMCS	*PORTLAND GROUP - LIMESTONE AND CALCAREOUS SANDSTONE*
	POSA-LMCS	*PORTLAND SAND FORMATION - LIMESTONE AND CALCAREOUS SANDSTONE*
	POST-LMST	*PORTLAND STONE FORMATION - LIMESTONE*
	KC-MDST	*KIMMERIDGE CLAY FORMATION - MUDSTONE*
	KC-SISD	*KIMMERIDGE CLAY FORMATION - SILTSTONE AND SANDSTONE*
	AGSP-SDST	*ARNGROVE SPICULITE MEMBER - SANDSTONE*
	AMC-MDST	*AMPTHILL CLAY FORMATION - MUDSTONE*
	AMKC-MDST	*AMPTHILL CLAY FORMATION AND KIMMERIDGE CLAY FORMATION (UNDIFFERENTIATED) - MUDSTONE*
	BYSA-SDST	*BECKLEY SAND MEMBER - SANDSTONE*
	KTON-SDST	*KINGSTON FORMATION - SANDSTONE*
	LITC-LSMD	*LITTLEMORE MEMBER - LIMESTONE AND MUDSTONE, INTERBEDDED*
	OKLY-LSMD	*OAKLEY MEMBER - LIMESTONE AND MUDSTONE, INTERBEDDED*
	STFD-LMST	*STANFORD FORMATION - LIMESTONE*
	TECY-SDSL	*TEMPLE COWLEY MEMBER - SANDSTONE AND SILTSTONE, INTERBEDDED*
	WEY-MDST	*WEYMOUTH MEMBER - MUDSTONE*
	WWB-MDST	*WEST WALTON FORMATION - MUDSTONE*
	WYLS-LMST	*WHEATLEY LIMESTONE MEMBER - LIMESTONE*
	KLC-MDST	*KELLAWAYS CLAY MEMBER - MUDSTONE*
	KLS-SDSL	*KELLAWAYS SAND MEMBER - SANDSTONE AND SILTSTONE, INTERBEDDED*
	PET-MDST	*PETERBOROUGH MEMBER - MUDSTONE*
	SBY-MDST	*STEWARTBY MEMBER - MUDSTONE*
	CB-LMST	*CORNBRASH FORMATION - LIMESTONE*
	FMB-LMST	*FOREST MARBLE FORMATION - LIMESTONE*
	FMB-MDST	*FOREST MARBLE FORMATION - MUDSTONE*
	TY-LMOOL	*TAYNTON LIMESTONE FORMATION - LIMESTONE, OOIDAL*
	WHL-LMST	*WHITE LIMESTONE FORMATION - LIMESTONE*
	RLD-MDST	*RUTLAND FORMATION - MUDSTONE*

Maidenhead, which similarly yielded thousands of artefacts (Wyer 1968; 1999; Cranshaw 1983; White *et al.* 2018). Between them, antiquarian collectors were responsible for adding 22 findspots to the distribution map of the Medway-Darent interfluve.

The Swanscombe and Greenhithe area may not be a ‘super site’ in the sense of a single site that dominates the archaeological record of the area. However, more palaeoliths have come from this district than from anywhere else in Britain (Wymer 1968, 320) the sheer concentration of prolific sites having the same skewing effect on archaeological distribution maps of the area. As a result of the ‘Swanscombe effect’, 22 of my dataset entries are mapped onto the Chalk in the immediate Swanscombe vicinity (Map 9.5)

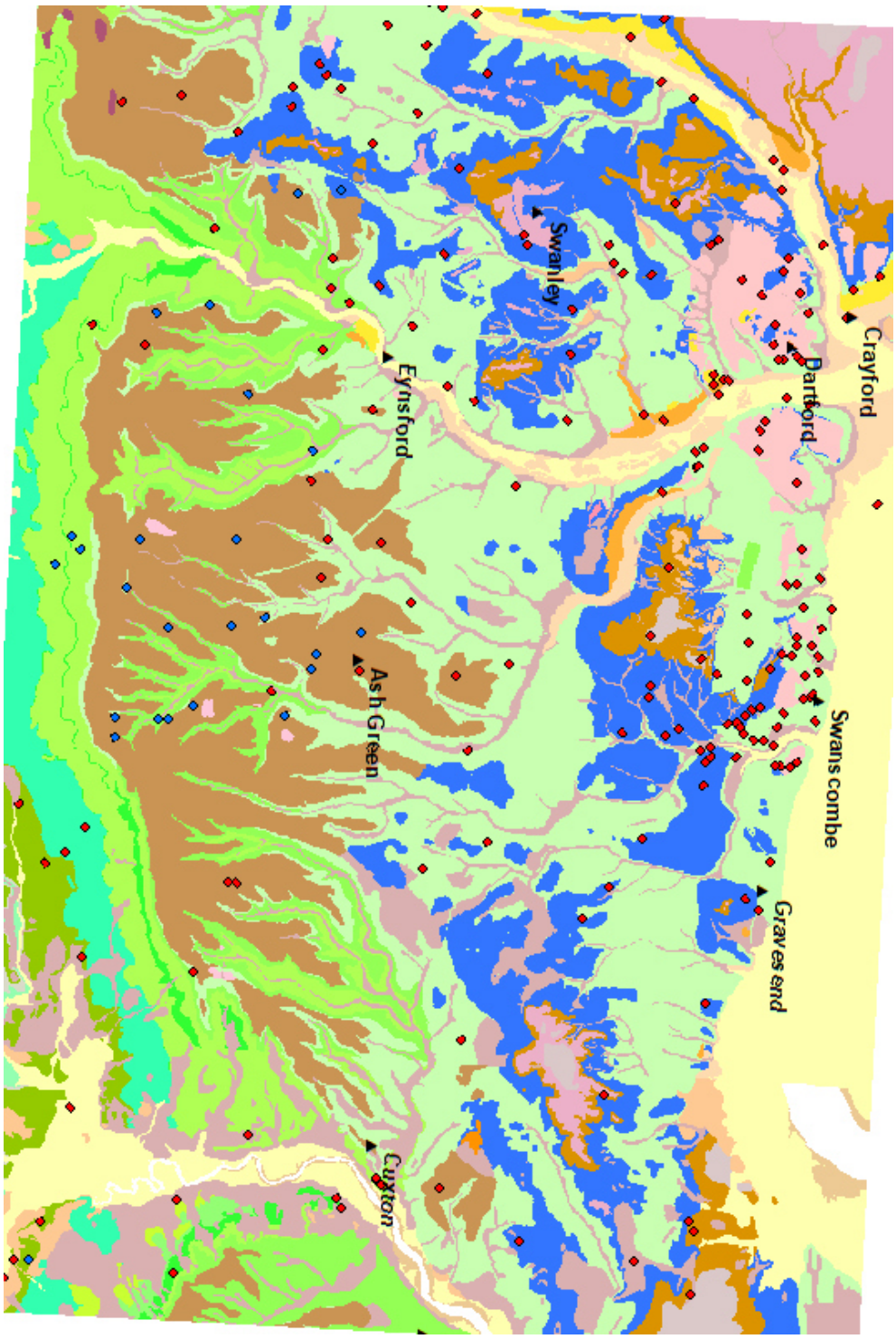
resulting in a findspot density for the interfluve of 23.83 per 100km^2. Removing Swanscombe from the equation would lower the findspot density to 15.88 per 100km^2.

Between them, Worthington Smith, Benjamin Harrison and Llewellyn Treacher were responsible for 140 (7.9%) of my 1772 total British dataset entries. However, collector bias in the archaeological record is not purely a consequence of antiquarian collecting. Modern fieldwalking or long-term collecting in a particular area can also have a significant impact on the record in that area, as can the field activities of amateur societies such as the Dover Archaeology Group and Surrey Archaeology Society's Plateau Archaeology Group. Usually concentrated in a relatively small area or on a single interfluve, the impact of their activities is intensified. For example, on the Merstham to Mole interfluve of the North Downs, 13 (42%) of the 31 findspots are attributable to the activities of the Surrey Archaeology Society.

On the South Chilterns, intensive field walking was carried out by Stephen Ford during the 1980s over a six kilometre by four kilometre (3 miles 1282 yards by 2 miles 854 yards) block of land in the North Stoke area of the Princes Risborough – Goring interfluve. Approximately 90% of arable fields in the area were field-walked, totalling 9.68km^2 (3.74mi^2) (Ford 1987; Ford and Hazell 1989). The Oxfordshire Historic Environment Record lists 17 Palaeolithic finds by Ford in the North Stoke area, 10 of which are identified in his unpublished field notes as being found on the hilltop or plateau slope. There are only three other findspots mapped in the area between the escarpment and the Thames, on the Wallingford Fan Gravels.

Another modern example of collector-bias distorting the archaeological record is in the Warsash/Chilling area of Fareham, Hampshire. The Portable Antiquities Scheme database for that county includes an entry (HAMP-017317) for a Lower Palaeolithic handaxe described as "one of 53 tools discovered during the finder's lifetime" between 1940 and 1970. The NGR given (SU 51 05) is the centre of the supposed area of collection, where there were several gravel pits.

Map 9.5. Darent-Medway interfluve showing Harrison's sites in blue. All other findspots are in red.



(Map Data BGS©UKRI 2019) For geology legend see following pages.

Geology Legend

- Towns
- Towns
- Surrey Findspots
- Harrison findspots
- Bell findspots
- Kent findspots

ew288_maidstone_superficial

LEX_RCS_I

ALV-CZPS	*ALLUVIUM - CLAY, SILTY, PEATY, SANDY [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XCZ	*HEAD - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XCZSV	*HEAD - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XVSZC	*HEAD - GRAVEL, SAND, SILT AND CLAY [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XZV	*HEAD - SILT AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD1-XSV	*RIVER TERRACE DEPOSITS, 1 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD2-XSV	*RIVER TERRACE DEPOSITS, 2 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD3-XSV	*RIVER TERRACE DEPOSITS, 3 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD4-XSV	*RIVER TERRACE DEPOSITS, 4 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD5-XSV	*RIVER TERRACE DEPOSITS, 5 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTDU-XCZ	*RIVER TERRACE DEPOSITS (UNDIFFERENTIATED) - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
TUFA-CATUFA	*TUFA - TUFA, CALCAREOUS*
CWF-XCZSV	*CLAY-WITH-FLINTS FORMATION - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*

ew288_maidstone_bedrock

LEX_RCS_I

LNM-SANDU	*LENHAM FORMATION - SAND*
TAB-SSCL	*THANET FORMATION - SAND, SILT AND CLAY*
SECK-CHLK	*SEAFORD CHALK FORMATION - CHALK*
LECH-CHLK	*LEWES NODULAR CHALK FORMATION - CHALK*
NPCH-CHLK	*NEW PIT CHALK FORMATION - CHALK*
HCK-CHLK	*HOLYWELL NODULAR CHALK FORMATION - CHALK*
WMCH-CHLK	*WEST MELBURY MARLY CHALK FORMATION - CHALK*
WZCK-CHLK	*WEST MELBURY MARLY CHALK FORMATION AND ZIG ZAG CHALK FORMATION (UNDIFFERENTIATED) - CHALK*
ZZCH-CHLK	*ZIG ZAG CHALK FORMATION - CHALK*
GLT-MDST	*GAULT FORMATION - MUDSTONE*
AC-STMD	*ATHERFIELD CLAY FORMATION - SANDSTONE AND MUDSTONE*
FO-SDST	*FOLKESTONE FORMATION - SANDSTONE*
HY-SDLM	*HYTHE FORMATION - SANDSTONE AND [SUBEQUAL/SUBORDINATE] LIMESTONE, INTERBEDDED*
SAB-SDSM	*SANDGATE FORMATION - SANDSTONE, SILTSTONE AND MUDSTONE*
WC-LMST	*WEALD CLAY FORMATION - LIMESTONE*
WC-MDST	*WEALD CLAY FORMATION - MUDSTONE*
WC-SDST	*WEALD CLAY FORMATION - SANDSTONE*
TWS-MDST	*TUNBRIDGE WELLS SAND FORMATION - MUDSTONE*
TWS-SDSL	*TUNBRIDGE WELLS SAND FORMATION - SANDSTONE AND SILTSTONE, INTERBEDDED*
WDC-MDST	*WADHURST CLAY FORMATION - MUDSTONE*

ew287_sevenoaks_superficial

LEX_RCS_I

ALV-XCZSV	*ALLUVIUM - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
T1T2-XSV	*RIVER TERRACE DEPOSITS, 1 TO 2 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XCZSV	*HEAD - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD1-XSV	*RIVER TERRACE DEPOSITS, 1 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD2-XSV	*RIVER TERRACE DEPOSITS, 2 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD3-XSV	*RIVER TERRACE DEPOSITS, 3 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD4-XSV	*RIVER TERRACE DEPOSITS, 4 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTDU-XCZ	*RIVER TERRACE DEPOSITS (UNDIFFERENTIATED) - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
CWF-XCZSV	*CLAY-WITH-FLINTS FORMATION - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
DBLB-XSV	*DISTURBED BLACKHEATH BEDS - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*

ew287_sevenoaks_bedrock

LEX_RCS_I

LSNCK-CHLK	*LEWES NODULAR CHALK FORMATION, SEAFORD CHALK FORMATION AND NEWHAVEN CHALK FORMATION (UNDIFFERENTIATED) - CHALK*
NPCH-CHLK	*NEW PIT CHALK FORMATION - CHALK*
GLML-CAMDST	*GLAUCONITIC MARL MEMBER - MUDSTONE, CALCAREOUS*
HNCK-CHLK	*HOLYWELL NODULAR CHALK FORMATION AND NEW PIT CHALK FORMATION (UNDIFFERENTIATED) - CHALK*
MR-CHLK	*MELBOURN ROCK MEMBER - CHALK*
WZCK-CHLK	*WEST MELBURY MARLY CHALK FORMATION AND ZIG ZAG CHALK FORMATION (UNDIFFERENTIATED) - CHALK*
GLT-MDST	*GAULT FORMATION - MUDSTONE*
UGS-SISD	*UPPER GREENSAND FORMATION - SILTSTONE AND SANDSTONE*
AC-MDST	*ATHERFIELD CLAY FORMATION - MUDSTONE*
FO-SDST	*FOLKESTONE FORMATION - SANDSTONE*
HY-SDLM	*HYTHE FORMATION - SANDSTONE AND [SUBEQUAL/SUBORDINATE] LIMESTONE, INTERBEDDED*
SAB-STMD	*SANDGATE FORMATION - SANDSTONE AND MUDSTONE*
WC-LMST	*WEALD CLAY FORMATION - LIMESTONE*
WC-MDST	*WEALD CLAY FORMATION - MUDSTONE*
WC-SDST	*WEALD CLAY FORMATION - SANDSTONE*
ARS-SDST	*ARDINGLY SANDSTONE MEMBER - SANDSTONE*
CKST-CALSST	*CUCKFIELD STONE BED - SANDSTONE, CALCAREOUS*
GRC-MDST	*GRINSTEAD CLAY MEMBER - MUDSTONE*
LGRC-MDST	*LOWER GRINSTEAD CLAY - MUDSTONE*
LTW-SDSL	*LOWER TUNBRIDGE WELLS SAND - SANDSTONE AND SILTSTONE, INTERBEDDED*
LTW-SDSM	*LOWER TUNBRIDGE WELLS SAND - SANDSTONE, SILTSTONE AND MUDSTONE*
TWS-SDSL	*TUNBRIDGE WELLS SAND FORMATION - SANDSTONE AND SILTSTONE, INTERBEDDED*
UGRC-MDST	*UPPER GRINSTEAD CLAY - MUDSTONE*
UTW-SDSL	*UPPER TUNBRIDGE WELLS SAND - SANDSTONE AND SILTSTONE, INTERBEDDED*
WDC-FEST	*WADHURST CLAY FORMATION - IRONSTONE*
WDC-MDST	*WADHURST CLAY FORMATION - MUDSTONE*
ASD-SDSM	*ASHDOWN FORMATION - SANDSTONE, SILTSTONE AND MUDSTONE*

ew272_chatham_superficial

LEX_RCS_I

ALV-CZPS	*ALLUVIUM - CLAY, SILTY, PEATY, SANDY [UNLITHIFIED DEPOSITS CODING SCHEME]*
ALV-XCZSV	*ALLUVIUM - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
ALV-XZC	*ALLUVIUM - SILT AND CLAY [UNLITHIFIED DEPOSITS CODING SCHEME]*
KPGR-XSV	*KEMPTON PARK GRAVEL FORMATION - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
BTFU-XCZS	*BEACH AND TIDAL FLAT DEPOSITS (UNDIFFERENTIATED) - CLAY, SILT AND SAND [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XCZ	*HEAD - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XCZSV	*HEAD - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XVSZC	*HEAD - GRAVEL, SAND, SILT AND CLAY [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XZV	*HEAD - SILT AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD1-XCZ	*RIVER TERRACE DEPOSITS, 1 - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD1-XSV	*RIVER TERRACE DEPOSITS, 1 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD2-XSV	*RIVER TERRACE DEPOSITS, 2 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD3-XSV	*RIVER TERRACE DEPOSITS, 3 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD4-XSV	*RIVER TERRACE DEPOSITS, 4 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTDU-XCZ	*RIVER TERRACE DEPOSITS (UNDIFFERENTIATED) - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
CWF-XCZSV	*CLAY-WITH-FLINTS FORMATION - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*

ew272_chatham_bedrock

LEX_RCS_I

LNM-SAGR	*LENHAM FORMATION - SAND AND GRAVEL*
BGS-SANDU	*BAGSHOT FORMATION - SAND*
CLGB-CLSISA	*CLAYGATE MEMBER - CLAY, SILT AND SAND*
LC-CLSI	*LONDON CLAY FORMATION - CLAY AND SILT*
TAB-SSCL	*THANET FORMATION - SAND, SILT AND CLAY*
HWH-SAGR	*HARWICH FORMATION - SAND AND GRAVEL*
LMBE-SSCL	*LAMBETH GROUP - SAND, SILT AND CLAY*
SECK-CHLK	*SEAFORD CHALK FORMATION - CHALK*
LECH-CHLK	*LEWES NODULAR CHALK FORMATION - CHALK*
LSNCK-CHLK	*LEWES NODULAR CHALK FORMATION, SEAFORD CHALK FORMATION AND NEWHAVEN CHALK FORMATION (UNDIFFERENTIATED) - CHALK*
NPCH-CHLK	*NEW PIT CHALK FORMATION - CHALK*
GLML-CAMDST	*GLAUCONITIC MARL MEMBER - MUDSTONE, CALCAREOUS*
HCK-CHLK	*HOLYWELL NODULAR CHALK FORMATION - CHALK*
HNCK-CHLK	*HOLYWELL NODULAR CHALK FORMATION AND NEW PIT CHALK FORMATION (UNDIFFERENTIATED) - CHALK*
WMCH-CHLK	*WEST MELBURY MARLY CHALK FORMATION - CHALK*
WZCK-CHLK	*WEST MELBURY MARLY CHALK FORMATION AND ZIG ZAG CHALK FORMATION (UNDIFFERENTIATED) - CHALK*
ZZCH-CHLK	*ZIG ZAG CHALK FORMATION - CHALK*
GLT-MDST	*GAULT FORMATION - MUDSTONE*
FO-SDST	*FOLKESTONE FORMATION - SANDSTONE*

ew271_dartford_superficial

LEX_RCS_I

ALV-CZPS	*ALLUVIUM - CLAY, SILTY, PEATY, SANDY [UNLITHIFIED DEPOSITS CODING SCHEME]*
ALV-XCZSV	*ALLUVIUM - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
TRD-XCZ	*TIDAL RIVER OR CREEK DEPOSITS - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
KPGR-XSV	*KEMPTON PARK GRAVEL FORMATION - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
CFSI-XCZ	*CRAYFORD SILT MEMBER - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
HAGR-XSV	*HACKNEY GRAVEL MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
ILSI-XCZ	*ILFORD SILT MEMBER - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
LHGR-XSV	*LYNCH HILL GRAVEL MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
TPGR-XSV	*TAPLOW GRAVEL FORMATION - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
BHT-XSV	*BOYN HILL GRAVEL MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
BPGR-XSV	*BLACK PARK GRAVEL MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
STGR-XSV	*STANMORE GRAVEL FORMATION - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
WHGR-XSV	*WELL HILL GRAVEL FORMATION - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
DASI-XCZ	*DARTFORD SILT MEMBER - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XCZSV	*HEAD - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XVSZC	*HEAD - GRAVEL, SAND, SILT AND CLAY [UNLITHIFIED DEPOSITS CODING SCHEME]*
PEAT-P	*PEAT - PEAT [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTDU-XSV	*RIVER TERRACE DEPOSITS (UNDIFFERENTIATED) - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
CHGR-XSV	*CHELSFIELD GRAVEL FORMATION - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
CWF-XCZSV	*CLAY-WITH-FLINTS FORMATION - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*

ew271_dartford_bedrock

LEX_RCS_I

CLGB-SSCL	*CLAYGATE MEMBER - SAND, SILT AND CLAY*
LC-CLSI	*LONDON CLAY FORMATION - CLAY AND SILT*
TAB-SANDU	*THANET FORMATION - SAND*
HWH-SAGR	*HARWICH FORMATION - SAND AND GRAVEL*
LMBE-SSCL	*LAMBETH GROUP - SAND, SILT AND CLAY*
SNCK-CHLK	*SEAFORD CHALK FORMATION AND NEWHAVEN CHALK FORMATION (UNDIFFERENTIATED) - CHALK*
LECH-CHLK	*LEWES NODULAR CHALK FORMATION - CHALK*
LSNCK-CHLK	*LEWES NODULAR CHALK FORMATION, SEAFORD CHALK FORMATION AND NEWHAVEN CHALK FORMATION (UNDIFFERENTIATED) - CHALK*
NPCH-CHLK	*NEW PIT CHALK FORMATION - CHALK*
HCK-CHLK	*HOLYWELL NODULAR CHALK FORMATION - CHALK*
WZCK-CHLK	*WEST MELBURY MARLY CHALK FORMATION AND ZIG ZAG CHALK FORMATION (UNDIFFERENTIATED) - CHALK*
GLT-MDST	*GAULT FORMATION - MUDSTONE*
FO-SDST	*FOLKESTONE FORMATION - SANDSTONE*

ew258_259_southend_and_foulness_superficial

LEX_RCS_I

ALV-CZPS	*ALLUVIUM - CLAY, SILTY, PEATY, SANDY [UNLITHIFIED DEPOSITS CODING SCHEME]*
ALV-XCZSV	*ALLUVIUM - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
T1T2-XSV	*RIVER TERRACE DEPOSITS, 1 TO 2 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
TFD-XCZ	*TIDAL FLAT DEPOSITS - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
TFD-XSZ	*TIDAL FLAT DEPOSITS - SAND AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
LHGR-XSV	*LYNCH HILL GRAVEL MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
TPGR-XSV	*TAPLOW GRAVEL FORMATION - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
LOFT-DMTN	*LOWESTOFT FORMATION - DIAMICTON*
GFDMP-XSV	*GLACIOFLUVIAL DEPOSITS, MID PLEISTOCENE - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
STGR-XSV	*STANMORE GRAVEL FORMATION - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
BSA-S	*BLOWN SAND - SAND [UNLITHIFIED DEPOSITS CODING SCHEME]*
BTFU-SDSH	*BEACH AND TIDAL FLAT DEPOSITS (UNDIFFERENTIATED) - SEDIMENT, SHELL (SHELLS)*
BTFU-XCZS	*BEACH AND TIDAL FLAT DEPOSITS (UNDIFFERENTIATED) - CLAY, SILT AND SAND [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XCZ	*HEAD - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XCZSV	*HEAD - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
MBD-SDSH	*MARINE BEACH DEPOSITS - SEDIMENT, SHELL (SHELLS)*
RTD1-XCZ	*RIVER TERRACE DEPOSITS, 1 - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD1-XSV	*RIVER TERRACE DEPOSITS, 1 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD2-XCZ	*RIVER TERRACE DEPOSITS, 2 - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD2-XSV	*RIVER TERRACE DEPOSITS, 2 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD3-XCZ	*RIVER TERRACE DEPOSITS, 3 - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD3-XSV	*RIVER TERRACE DEPOSITS, 3 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD4-XSV	*RIVER TERRACE DEPOSITS, 4 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTFD-XCZ	*RAISED TIDAL FLAT DEPOSITS - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
SGAO-XSV	*SAND AND GRAVEL OF UNCERTAIN AGE AND ORIGIN - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
T1T3-XCZ	*RIVER TERRACE DEPOSITS, 1 TO 3 - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
T1T3-XSV	*RIVER TERRACE DEPOSITS, 1 TO 3 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
T2T3-XSV	*RIVER TERRACE DEPOSITS, 2 TO 3 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*

ew258_259_southend_and_foulness_bedrock

LEX_RCS_I

BGS-SANDU	*BAGSHOT FORMATION - SAND*
CLGB-CLSISA	*CLAYGATE MEMBER - CLAY, SILT AND SAND*
LC-CLSISA	*LONDON CLAY FORMATION - CLAY, SILT AND SAND*
TAB-SANDU	*THANET FORMATION - SAND*
HWH-SAGR	*HARWICH FORMATION - SAND AND GRAVEL*
LMBE-CLSISA	*LAMBETH GROUP - CLAY, SILT AND SAND*

ew257_romford_superficial

LEX_RCS_I

ALV-CZPS	*ALLUVIUM - CLAY, SILTY, PEATY, SANDY [UNLITHIFIED DEPOSITS CODING SCHEME]*
ALV-XCZSV	*ALLUVIUM - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
TRD-XCZ	*TIDAL RIVER OR CREEK DEPOSITS - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
KPGR-XSV	*KEMPTON PARK GRAVEL FORMATION - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
ROSI-XCZ	*RODING SILT MEMBER - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
HAGR-XSV	*HACKNEY GRAVEL MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
ILSI-XCZ	*ILFORD SILT MEMBER - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
LHGR-XSV	*LYNCH HILL GRAVEL MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
TPGR-XSV	*TAPLOW GRAVEL FORMATION - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
BHT-XSV	*BOYN HILL GRAVEL MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
BPGR-XSV	*BLACK PARK GRAVEL MEMBER - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
LOFT-DMTN	*LOWESTOFT FORMATION - DIAMICTON*
GFDMP-XSV	*GLACIOFLUVIAL DEPOSITS, MID PLEISTOCENE - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
GLLMP-XCZS	*GLACIOLACUSTRINE DEPOSITS, MID PLEISTOCENE - CLAY, SILT AND SAND [UNLITHIFIED DEPOSITS CODING SCHEME]*
WOGR-XSV	*WOODFORD GRAVEL FORMATION - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
STGR-XSV	*STANMORE GRAVEL FORMATION - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XCZSV	*HEAD - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
PEAT-P	*PEAT - PEAT [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTDU-XSV	*RIVER TERRACE DEPOSITS (UNDIFFERENTIATED) - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
SUPD-SED	*SUPERFICIAL DEPOSITS - SEDIMENT*

ew257_romford_bedrock

LEX_RCS_I

BGS-SANDU	*BAGSHOT FORMATION - SAND*
CLGB-CLSISA	*CLAYGATE MEMBER - CLAY, SILT AND SAND*
CLGB-SANDU	*CLAYGATE MEMBER - SAND*
LC-CLSISA	*LONDON CLAY FORMATION - CLAY, SILT AND SAND*
TAB-SANDU	*THANET FORMATION - SAND*
HWH-SAGR	*HARWICH FORMATION - SAND AND GRAVEL*
LMBE-CLSISA	*LAMBETH GROUP - CLAY, SILT AND SAND*
LSNCK-CHLK	*LEWES NODULAR CHALK FORMATION, SEAFORD CHALK FORMATION AND NEWHAVEN CHALK FORMATION (UNDIFFERENTIATED) - CHALK*

v) Visualising the relationship between British and French policy and research strategies and the shape of the Lower-Middle Palaeolithic archaeological record.

I have used the Chalk uplands of northern France as a control area throughout my research. However difficulty in accessing a suitable geological mapping database, coupled with the thick and extensive loess deposits, made it impossible to use French geomorphological data in the same way as for Britain. The loess cover also resulted in there being few large-scale antiquarian collectors in France, where official archaeology and the Government-funded *Institut National de Recherches Archéologiques* (INRAP) are dominant. As a result of these factors, the shape of the archaeological record in the two countries is very different.

In Chapter Eight I explored the substantial differences between government policy and research strategies in Britain and France. Here, I present the results of my analysis of the finds circumstances of my 167 French dataset entries, which established the numbers attributable to official or amateur archaeological fieldwork, surface or chance discovery, aggregates/brickearth extraction and infrastructure/urbanisation. When compared with my analysis of my British dataset the differences are substantial.

In France the Ministry of Culture's Division of Archaeology, employing >340 archaeologists (Depaepe and Salas-Rossenbach 2013), is responsible for national policy development, regulation and monitoring of heritage legislation, heritage protection measures and state-led scientific and technical monitoring during archaeological research operations. The whole system is funded by a Government tax on all development projects, which also subsidises archaeological evaluation of social or private housing. Archaeological ground is considered national property and any archaeological finds also become the property of the State. In this way, archaeology is viewed as a public service (Demoule 2016; Depaepe 2016).

The selection of sites for preventive archaeological excavation rests with the French state and INRAP has a global budget of ~170M euros a year (Catteddu *et al.* 2012).

This is in sharp contrast to Britain, where policy is decreed by Government departments with an ever-strengthening legislative presumption in favour of development and, unless Treasure Trove, archaeological finds are considered to be the property of the surface owner of the land. Responsibility for the monitoring and implementation of planning and heritage legislation rests with increasingly under-resourced local authorities with falling staff numbers and reduced and reducing control over local planning decisions. An understanding of how to deal with Lower-Middle Palaeolithic archaeology is rare among local authority archaeologists and practically non-existent among local planning officers.

Differences in the nature and amount of archaeological fieldwork

One of the biggest differences between Britain and France lies in the number of archaeological discoveries made as a result of fieldwork, including watching briefs, archaeological survey, excavation and fieldwalking. For England, only 141 (7.9%) of the 1772 entries in my total dataset are the result of archaeological fieldwork of any kind. In France the number is 99 (59.3%) out of 167 (Table 9.9).

The difference between the percentage of fieldwork conducted under the aegis of the 'state' (both national and local) and that carried out by amateurs is equally disproportionate. In France 99 dataset entries resulted from Government/State ordered archaeology, in line with the Government policies and strategies detailed in Chapter Eight. Of these, 50 were discovered as a result of diagnostics prior to infrastructure development and 49 were found during diagnostics prior to excavation. All 99 were conducted by professional archaeologists.

A prime example is Bettencourt-Saint-Ouen "La Queue de la Fôret", Somme, discovered during archaeological evaluation as part of works on the Autoroute A16 Nord. The evaluation was carried out because of the favourable topographic position for the preservation of prehistoric archaeology. During the subsequent salvage excavation, five levels of Middle Palaeolithic occupation were identified in a solution hollow in the Chalk. This had preserved a pedo-sedimentary sequence allowing reconstruction of the palaeoenvironment (unpublished archaeological report DRAC). As discussed in Chapter Eight, the discovery of such Lower-Middle

Palaeolithic sites requires sondages and trial trenching, rather than the more superficial surveying carried out in Britain on, for example, HS2. Air photography, fieldwalking and geophysical survey are rarely of use for Middle Pleistocene archaeology, unless overlying deposits are shallow (Hind and Hey 2014, 10).

Of my 141 British dataset entries attributed to fieldwork in its broadest sense, 50 (35.5%) were the result of amateur activity. The professionally conducted fieldwork was, in most areas, small-scale and to comply with local planning legislation.

In the North Chilterns only four (2.1%) of the entries are attributable to fieldwork, three professional excavations and one occurrence of amateur fieldwalking. In the South Chilterns the total of 28 includes 9 small-scale professional excavations, 1'amateur' excavation by John Wymer and 18 amateur fieldwalking finds, including those resulting from the systematic fieldwalking carried out by Ford on the Princes Risborough to Goring interfluve.

In Kent, the unusually high percentage (for my British data) of 61 (13%) total dataset entries attributed to fieldwork is thanks to a combination of work on large infrastructure projects such as the Channel Tunnel rail link and M25 construction, the ALSF-funded Medway Valley Palaeolithic Project, Historic England-funded Stour Basin Palaeolithic project and the frequent activities of the Dover Archaeology Group on the Chalk Downs around Dover. Professional archaeologists conducted fieldwork in 42 of the 61 cases, the remaining 19 being the work of amateurs. All 10 (6.3%) of the Surrey Downs entries attributed to fieldwalking are the result of amateur activity, particularly by the Surrey Archaeological Society Plateau Archaeology Group.

On the Sussex Downs, the five (2.6%) fieldwork entries are due to three small research excavations and amateur fieldwalking finds. On the Hampshire South Downs, the 33 (8.9%) fieldwork entries are split almost equally between professional archaeological activities (18) and amateur fieldwalking finds.

Differences between the number of finds made on the surface and/or by chance.

Although due primarily to the geomorphological differences between the two countries, with the thick loess covering in France rendering surface finds unlikely unless released by infrastructure developments or quarrying, the impact of the different French and British archaeological regimes also affects the number of surface or chance finds and those with no recorded provenance. This is analysed in Table 9.9. For the purpose of my research, if somewhere in the entry for an artefact with no recorded provenance it was described as 'found' then I counted it as a surface or chance find. Otherwise, it remained as 'no provenance' and was omitted from my analysis. The number of my British total dataset entries recorded as being surface or chance finds is 669, or 37.8%. This varies from area to area, ranging from 31.9% on the South Chilterns to 44.5% on the Sussex Downs, but never falls below 30%. Only one (0.6%) of my French entries is recorded as being a surface find, from a field at Catigny-Ouest, made by Vignard during his collecting activities along the line of the Canal du Nord (*cf.* Chapter Seven).

The number of French entries with no recorded provenance is also substantially smaller. While 497 (28%) of British entries lack provenance information, the French figure is 28 (16.8%). In total, 65.8% (1166) of the 1772 British entries in my Chalklands Lower-Middle Palaeolithic dataset were either recorded as surface/chance finds or have no recorded provenance. For France, the percentage is only 17.4%.

Differences in the number of total Chalklands Lower-Middle Palaeolithic dataset entries attributed to aggregates/brickearth extraction.

As discussed above, there is no significant difference between the numbers of French and British dataset entries attributed to quarrying for gravel, with a total of 324 (18.3%) British entries and 32 (19.2%) French entries. The difference is greater in the case of brickearth extraction sites, with 6.6% (11) French entries attributed to brickearth extraction while the British figure is only 3% (54 entries). In both countries, the number of finds made as a result of gravel extraction processes is substantially higher than those

Table 9.8 Number of total Chalklands Lower-Middle Palaeolithic dataset entries attributable to archaeological fieldwork.

Study area	Total dataset entries	Fieldwork/Archaeology	% of total	Notes
North Chilterns	188	4	2.1%	3 professional excavations; 1 amateur fieldwalking 9 small-scale professional excavations,1 'amateur' excavation by John Wymer and 18 amateur fieldwalking finds, including 15 Ford sites.
South Chilterns	395	28	7.1%	A mixture of amateur and professional/official. This unusually large percentage of archaeological interventions is due to Kent's participation in ALSF-funded projects such as the Medway Valley Palaeolithic Project, a number of large infrastructure projects (M25; Channel Tunnel rail link) and the activities of the Dover Archaeology Group.
Kent North Downs	470	61	13.0%	All amateur. Includes 7 fieldwalking sites and 3 Plateau Archaeology Group excavations
Surrey Downs	158	10	6.3%	3 small research excavations by A.G. Woodcock and 2 amateur fieldwalking finds by J. Bell.
Sussex Downs	191	5	2.6%	18 professional activities, including field survey, watching briefs and excavations, plus 15 amateur fieldwalking finds.
Hampshire	370	33	8.9%	
Total		**141**	**7.9%**	
Hauts de France	167	**99**	**59.3%**	All professional/official. 50 diagnostics due to infrastructure and 49 diagnostics prior to excavation

resulting from brickearth extraction. The truly significant difference between the two countries lies in the fact that 20 (12%) of the French gravel and brickearth extraction sites identified during the late 19th and early 20th centuries have subsequently been routinely the subject of watching briefs and diagnostic/rescue archaeology when proposed developments have been likely to impinge. The best known, such as Carrière Carpentier at Abbeville, have also been the subject of research excavations.

In England, only two of my dataset entries are recorded as being the result of watching briefs on gravel pits known to be prolific, those at Kimbridge Farm and Dunbridge, both in the Test Valley Hampshire. In Kent, Wrotham Quarry, Trottiscliffe, was the subject of archaeological sampling in 2009/10, presumably because of its proximity to one of Benjamin Harrison's richest collecting areas.

This grand total of three (0.17%) reflects the often laissez-faire approach to the Palaeolithic archaeological resource under the British planning system, when compared with the proactive French system. While the most exceptional sites, such as Barnfield Pit, are protected through scheduling under the Ancient Monuments and Archaeological Areas legislation, the potential dangers of this situation for the Lower-Middle Palaeolithic archaeological resource are demonstrated in the case of the Caddington Cottages site described in Chapter Eight.

Differences in the number of total dataset entries attributed to infrastructure and urbanisation processes.

The biggest difference between the number of dataset attributions in England and France is that relating to the processes of urbanisation (Table 9.10).

Proactive French Government policy has resulted in 46.1% (77) of entries being the result of such urbanisation, predominantly road and canals. In England the overall percentage is only 5.5% (97 entries), the majority of which were because of commercial and domestic building development.

There is also a stark contrast between the figures for the two countries relating to canal construction, in this case for historical reasons. England's extensive canal network was built largely during the 18th and early 19th

centuries, before the resolution of the ‘antiquity of man’ question and the emergence of a body of interested and informed antiquarian collectors. Not a single dataset entry is attributed to British canal construction whereas had canal excavation in Britain begun 100 years later its sheer scale would, potentially, have resulted in numerous discoveries. Construction of the French Canal du Nord, in contrast, developed to help French coal mining companies withstand foreign competition, did not begin until 1908, halted in 1914, because of the First World War and did not resume until 1960. Actively monitored by collectors between 1908 and 1914, most notably by Victor Commont, the Canal was responsible for 23 (71.8%) of my thirty-two French canal building dataset entries. The remaining 9 are discoveries made during the construction of the Canal Seine-Nord Europe since 2016. In total, canal building accounts for 19.2% French dataset entries.

A further 20.3% (34) of French entries are the result of road construction and repairs, reflecting the high level of official archaeological intervention discussed above. Only 20 (1.1%) British entries are attributable to road works, almost all chance discoveries during building and repair. Only two French entries, both late 20th century, relate to the railways, one (Riencourt-les-Bapaume) to the building of the TGV Nord and the other (Verdilly “le Bois des Peupliers”) to the TGV Est. With the exception of four relating to the Channel Tunnel rail link (Cobham, Gravesend Near Tollgate, Gravesend Springhead and Guston Swingate) the 1% of British railway construction entries all date from the late 19th/early 20th centuries.

The differing cumulative impact of British and French archaeological policies and strategies on the archaeological records of the two countries can be seen in Fig. 9.15 below.

v) Summary

In this chapter, rather than taking the distribution patterns in the Lower-Middle Palaeolithic archaeological record of the Chalklands of northwest Europe at face value, I have sought to visualise the archaeological data in a different way. To do so, I isolated four of the principal variables underpinning that archaeological record. These were:

i) geomorphology/geomorphological history, addressed through the relationship between Clay-with-flints survival and findspot density;

Table 9.9 Comparative analysis of surface and chance finds and those with no known provenance

Study area	Total dataset entries	Surface/chance finds	% of total	No recorded provenance	% of total	Surface finds plus no recorded provenance	% of total
North Chilterns	188	74	39.4%	43	22.9%	117	62.2%
South Chilterns	395	126	31.9%	83	21.0%	209	52.9%
Kent North Downs	470	151	32.1%	170	36.2%	321	68.3%
Surrey Downs	158	70	44.3%	32	20.3%	102	64.6%
Sussex Downs	191	85	44.5%	73	38.2%	158	82.7%
Hampshire South Downs	370	163	44.1%	96	25.9%	259	70.0%
Total	**1772**	**669**	**37.8%**	**497**	**28.0%**	**1166**	**65.8%**
Hauts de France	167	1	0.6%	28	16.8%	29	17.4%

Table 9.10 Comparative table of total Chalklands Lower-Middle Palaeolithic dataset entries attributable to urbanisation/infrastructure development

Infrastructure/ urbanisation	France	England
Roads	34	20
Canals	32[1]	0
Railways	2	18
Building works	5	37
Utilities	4	22
Total	77	97
% of total dataset entries	**46.1% of 157 entries**	**5.5% of 1772 entries**

1.Exclusively the Canal du Nord and the Canal Seine-Nord Europe

ii) late 19th/early 20th century industrialisation processes and their relationship to findspot density. The processes I included were aggregates and brickearth extraction, urbanisation, infrastructure development and railway construction;

iii) the scale of antiquarian collector activities in my core study areas and its relationship to findspot density;

iv) the relationship between Government policy and research strategies and the formation of the archaeological record in Britain and France.

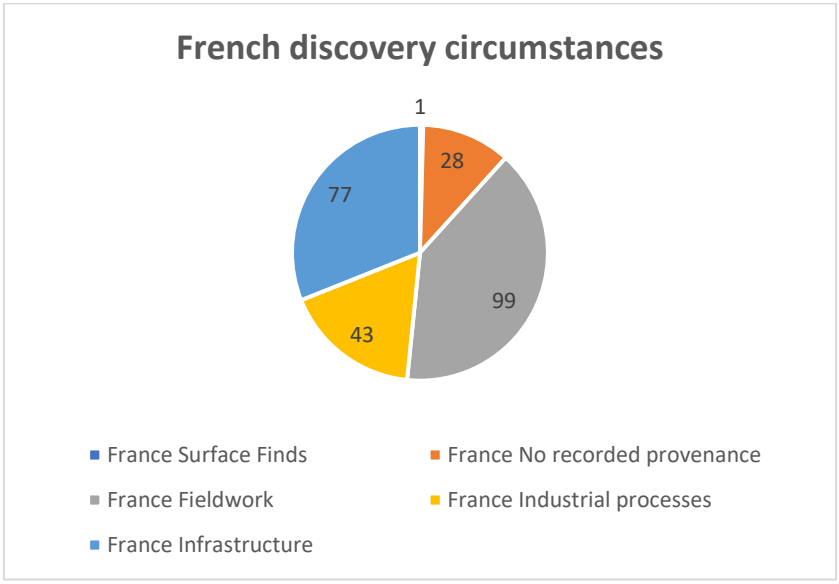
Fig. 9.16 illustrates the sequence of events through which artefacts have entered the British archaeological record, creating the findspot distribution patterns on which interpretations of early human landscape preference are based.

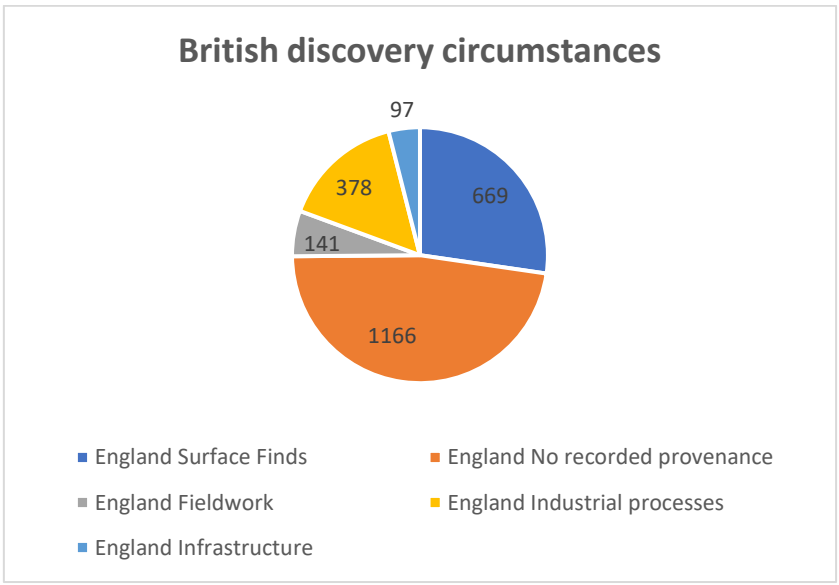
My analysis of these variables established that:

a) Geomorphology has been the first and most influential of the variables impacting on findspot distribution patterns:

- in line with my working hypothesis, areas with the lowest surviving % of Clay-with-flints have the lowest findspot density, as do those with the highest %. The result is a non-linear relationship between Clay-with-flints survival and findspot density owing to the Clay-with-flints having been impacted by multiple successive periglacial processes which were themselves non-linear;
- artefacts found in Head deposits on valley sides and bottoms are likely to have originated from the plateaux;

Fig. 9.15 Cumulative impact of differing policies and strategies on the finds circumstances of French and British Chalklands Lower-Middle Palaeolithic dataset entries.





- the presence or absence of the necessary geological deposits, river gravels, brickearth and Chalk, was the primary driver of whether or not aggregates extraction, the next most significant contributor to the archaeological record, occurred;
- the huge difference in loess cover between Britain and France has resulted in major differences in the ways in which the archaeological records of the two countries have been created.

b) Late 19th/early 20th century industrialisation played the next most significant role in the creation of the archaeological record:

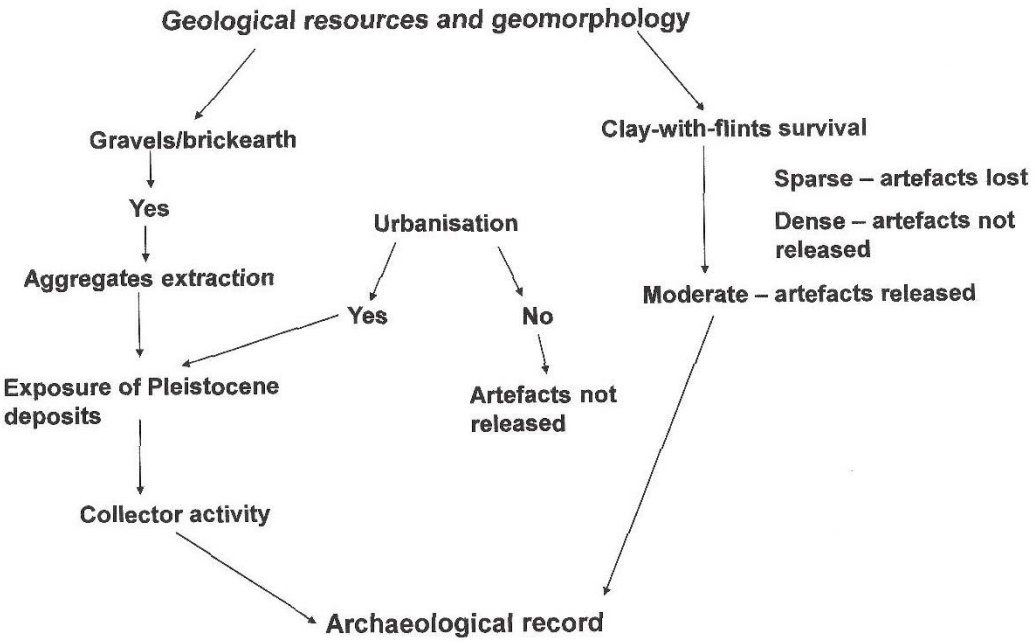
- aggregates and brickearth extraction were by far the most influential of these, contributing >20% of my dataset entries thanks to their large-scale exposure of Pleistocene sediments;
- although urbanisation and railway construction had a relatively limited direct impact on artefact discovery, their huge demand for aggregates led to increased exposure of Pleistocene sediments;
- this exposure created opportunities for large-scale antiquarian collecting.

c) Artefacts having been released from their Pleistocene deposits by geomorphological processes or/and industrialisation, it was the antiquarian collectors who collected them and recorded their locations, with varying degrees of accuracy, thus creating our findspot distribution maps:

- the concentration of antiquarian collecting in local areas, or in places where artefacts were known to be found, had a significant distorting effect on the archaeological record of an area;
- inadequate and/or inaccurate recording of findspots by collectors also introduced inaccuracies into the record;
- where there were no, or few, large-scale collectors – as on the Chalk of the South Downs – the archaeological record is correspondingly sparse.

e) Differing Government policies and strategies in the two countries have led to major differences in the ways in which artefacts/sites have entered the British and French records.

The sequence of events through which artefacts have entered the British Lower-Middle Palaeolithic archaeological record.



The collecting of amateur archaeologists and antiquarians, together with the localised distribution of aggregates extraction and economic development has resulted in a regional archaeological record that is both spatially and typologically biased (Hosfield 2005, 228). As my results demonstrate, the disparate preservation of Pleistocene sediments and the exposure of those sediments through quarrying, urban expansion and infrastructure development all played important roles in shaping distribution patterns in the archaeological record, as did the consequent antiquarian collecting. However, it was the nature of the geological deposits and the consequent geomorphological changes which were the starting point for all the other processes. Based on my results, the UPLA prediction that geomorphological processes have had a greater effect on findspot distribution patterns than any other single factor, is correct.

Chapter Ten. Discussion, implications and conclusion.

i) Introduction

There is what Binford (1972, 251) called a 'naïve notion' that the archaeological record is a direct reflection of the past, when it is, in fact, merely what remains after the impact on the original archaeological resource of a number of variables, operating both in the past and up to the present day. Focusing on the detailed Lower-Middle Palaeolithic record of the Chalk landscapes of southeast Britain and northern France, in this thesis I have proposed a new framework for looking at the archaeological data in relation to geomorphology and identified its impact on the creation of distribution patterns in that data. I have also investigated the impact on those patterns of three other significant variables – Victorian industrialisation, antiquarian collecting and Government heritage management policies and strategies – and demonstrated that apparent distribution patterns in the archaeology do not necessarily represent the original and temporally dynamic distribution of past human behaviour in deep time.

Interpretations of early human behaviour and landscape preference generally take as their starting point either the spatial distribution of artefacts across an individual archaeological site or that of findspots mapped across an area of landscape. Over the past 25 years, the focus of Palaeolithic archaeology has shifted, from site-centred narratives of place to identifying landscape-scale archaeological distribution patterns and using these to interpret early human landscape preference. Given that the majority of British Lower-Middle Palaeolithic artefacts have come from lowland river gravel contexts, the result has been that current interpretations focus almost exclusively on fluvial archaeology, leading to the predominance of 'river valley preference' models of early human landscape use and neglect of the upland archaeology.

In Chapter Three I critically reviewed a number of current interpretations, including those which either articulated or assumed implicitly that river valleys were used preferentially by early humans, who had largely ignored the Chalk plateaux. I considered models and hypotheses dealing with social organisation, demography, colonisation patterns and behaviour, assessing them in the context of the Unified Palaeolithic Landscape

Approach (UPLA) and the impact of geomorphological processes on the formation of the archaeological record. Table 3.2 summarises the weaknesses I identified in those interpretations which largely ignored the effects of geomorphology.

In reality, findspot distribution patterns tell us little about where early humans lived or how they actually used the landscape. They do, however, tell us where the archaeology is being transformed from primary to secondary context as artefacts are released into the archaeological record. They constitute the front-line between artefact preservation and release.

Gaps on findspot distribution maps may, in fact, be the areas of greatest archaeological potential and my research has shown that on the Chalklands of southeast Britain it is precisely those areas of the Chalk plateaux with significant surviving Clay-with-flints deposits but without any recorded findspots which have the greatest potential for artefact preservation. We must, therefore, relinquish our reliance on distribution maps and identify new ways of visualising our data and its meaning. Breaking down the landscape into individual blocks and analysing the factors that have influenced archaeological distribution within each of those blocks has provided me with a robust way of doing this.

In my research I set out to answer a number of questions, focused primarily on the geomorphological history of each landscape unit. Given the recognised preservation and release qualities of Clay-with-flints and the deposit's potential impact on the archaeological record, I investigated its differing degrees of survival across my core study areas. My research also addressed the questions of how far individual collecting activities, industrialisation and differences between British and French heritage management policies and strategies might have affected archaeological distribution patterns. In answering these questions, I wanted to understand the limitations and demonstrate the pitfalls of relying on findspot distribution maps as indicators of early human landscape preference.

My results have clearly shown that for interpretations of early human behaviour based on spatial distribution patterns in the archaeological record to be truly meaningful, that record must neither be read selectively, nor in isolation. Geological context and the geomorphological history of a landscape area must be the starting point for interpretation, which must

also take account of any other external variables that might have had a significant impact. In this chapter I will summarise and synthesise my results and consider the extent to which they have answered the research questions I posed in Chapter One. I will also consider the implications of those answers for the use of archaeological distribution patterns as reliable indicators of early human behaviour and landscape preference.

ii) A critical evaluation of the Lower-Middle Palaeolithic archaeological record of the Chalk uplands: a review of the evidence.

Geomorphology

Four of the seven research questions I set out to address were concerned with the nature and scale of the geomorphological changes that have taken place in my core and control study areas since the Middle Pleistocene and their implications for the archaeological record. Specifically, I wanted to identify any differences in geomorphological history between the regions and how the archaeology of each might consequently have been affected. I hoped also to establish whether high-ground scatters showed any uniformity in respect of their geological relationships and whether those relationships could be used to predict the potential location of other sites in the landscape. In particular, I wanted to test the UPLA prediction that geomorphology provides a more robust first-order explanation for artefact distribution patterns than early human habitat preference alone.

The majority of Lower-Middle Palaeolithic surface sites in southern England are on Chalk or Clay-with-flints (Wymer 1999, 48). Consequently, testing the impact of differential Clay-with-flints survival on the archaeological distribution patterns of the Chalklands was a key part of my research. This was based on my working hypothesis that where little Clay-with-flints survives finds will mostly have eroded away; where dense Clay-with-flints survives finds will be obscured by the geology; and between these two extremes there will be optimal conditions for erosional artefact release and recovery.

In his review of Scott-Jackson's work, Wenban-Smith identified five key questions relating to Clay-with-flints and the archaeology it contains (Scott-Jackson 2000b, 283). These are

- What was the origin of Clay-with-flints and when did it form?
- How much change and development has there been in the Clay-with-flints landscape since the Middle Pleistocene?
- What was the nature of the sedimentary processes operating throughout the Middle and Upper Pleistocene?
- By what process did archaeology become incorporated in the deposit and to what processes was it subsequently subjected?
- What is the consequent stratigraphic/chronological integrity of any Palaeolithic material now present in Clay-with-flints?

In this thesis I have addressed the first four of Wenban-Smith's questions and facilitated answers to the fifth.

There are substantial differences between my three core study areas in the amount of surviving Clay-with-flints, as well as in that surviving on the individual interfluves within each area. Taking the North Downs as a whole, 26.77% of the Chalk is covered by Clay-with-flints and for the Chilterns the figure is 22.71% (Table 9.1). For the South Downs, however, only 6.84% of the Chalk has a Clay-with-flints covering. Given its high percentage of Clay-with-flints cover, total findspot density per 100km^2 (38.6mi^2) is, as expected, also highest on the North Downs, at 73.19 per 100km^2 (38.6mi^2). On the Chilterns, however, the figure of 42.82 per 100km^2 (38.6mi^2) is lower than the 57.95 per 100km^2 (38.6mi^2) findspot density on the South Downs, despite the latter's much lower percentage of overall Clay-with-flints survival. This discrepancy can be explained by the disproportionately high findspot density of 22.73 per 100km^2 (38.6mi^2) on the Eastbourne-Cuckmere interfluve, despite it having only 10.61% Clay-with-flints survival. If the average South Downs figure of 6.44 per 100km^2 (38.6mi^2) findspots density is substituted for the Eastbourne-Cuckmere interfluve then the overall South Downs figure falls to 41.66 per 100km^2 (38.6mi^2) and the relationship between findspot density and Clay-with-flints survival is restored. The same is true if the South Downs median of 5.45 per 100km^2 (38.6mi2) is taken, giving a total findspot density of 40.67 per 100km^2 (38.6mi^2).

My analyses showed a relationship between findspot density and Clay-with-flints survival that, although clearest on the North and South Downs, also exists in the North Chilterns. In each area, findspot density rises as % Clay-

with-flints increases, up to a point at which density falls while % Clay-with-flints survival continues to increase. The significant differences in Clay-with-flints survival between the areas alters the exact point at which the change takes place, but the behavioural pattern is the same. With one or two exceptions, areas with a low surviving % of Clay-with-flints have the lowest findspot density, the heavily-eroded Clay-with-flints having released the greatest number of artefacts which have been removed subsequently by periglacial processes and lost from the archaeological record.

At an individual interfluve level, analysis of findspot distribution in relation to the edges of the Clay-with-flints deposits does not show a clear relationship between the % Clay-with-flints survival and the number of findspots around those edges (Fig. 9.12). However, the number of findspots on the edges of the Clay-with-flints on the South Downs overall is significantly higher (at 26.8% of total findspots) than on the North Downs and Chilterns (19.6% and 19.4% respectively). It appears that the preservational quality of the denser Clay-with-flints in the latter two regions has reduced the number of artefacts released, while more artefacts are eroding from the patchy Clay-with-flints on the South Downs. Where there is dense surviving Clay-with-flints, the blankness on the findspot distribution maps is as likely to be due to geomorphology as to true human absence. Consequently, the blank areas are those with the greatest Lower-Middle Palaeolithic potential.

My findspot distribution maps show that 13% of finds were made on Chalk, 7.2% on Clay-with-flints and 6.2% on colluvial Head deposits on the slopes or in valley bottoms. Although there is no clear relationship between percentage Clay-with-flints survival on an interfluve and the number of findspots on Head in its adjacent valleys, the soliflucted nature of the deposit means that artefacts mapped onto Head/Brickearth in the dry valley bottoms have come largely from the plateaux and valley sides and should be regarded as part of the archaeological record of the plateaux, not of the valley. At Bapchild, Kent (TQ936 624 and TQ931 627), for example, several hundred artefacts, mainly Levallois flakes, were discovered in Coombe Rock under deposits mapped as Head Brickearth. They had become incorporated in the Chalky deposit as it sludged down the hill from a nearby working place (Dines 1929; Wymer 1999).

Given that deposits of the Thames and its tributaries occur from the tops of the highest hills on the basin margins (~180m O.D.) to below sea-level in the Thames estuary (Gibbard 1999), their contents can also, in some instances, form part of the archaeological record of the upland areas. A.M. Bell's mainly surface sites at Limpsfield Common were discovered on soliflucted Head Gravel of the former river Darent, which once flowed across the area. The gravel had slumped down off the Chalk escarpment onto the Lower Greensand or Weald Clay (Gossling 1940; Wymer 1999). Meaningful interpretation of Lower-Middle Palaeolithic findspot distribution patterns must take into account that at least a percentage of the finds in Combe rock in the dry valleys and of Head/brickearth and Head gravel deposits in the river valleys will have originated on the plateaux. In the words of Worthington Smith (1894,87) "The valleys contain the sweepings of the hills".

In the higher landscape of southern Limburg, the majority of Middle Palaeolithic surface scatters are located along the edges of plateaux, often near the confluence of river valleys or on conspicuous promontories and all with wide views over the surrounding landscape. This has been interpreted as a topographical preference (Kolen *et al.* 1999) and similar patterns have been reported for other regions. Wide vistas over river valleys seem to have been a crucial factor in early human location choice (Drinkall 2013; Kolen *et al.* 1999; Scott-Jackson & Scott-Jackson 2010). Crucially, however, in Britain at least where loess cover is patchy or non-existent, Clay-with-flints *sensu lato* residual surface deposits feather out on the shoulders of valleys and on scarp slopes to expose the Clay-with-flints *sensu stricto* (Catt 2010). This increases the potential for artefact release and leads to surface assemblages eroding at plateau and terrace edges. Similarly, in Dutch South Limburg and Belgian Limburg loess deposits at the edges of south-south-west facing slopes on the elevated plateaux have generally been eroded to thin or non-existent, while upslope on the plateaux >20m of stratified sediments may be preserved (Glauberman 2016). While there were undoubtedly good reasons why early humans would have favoured sites with vistas overlooking river and dry valleys, some sites on high ground between two valleys could be the result of geomorphological processes and a coincidence of artefact preservation and release, with sites close to the edge being exposed through erosion

(Harp 2005). This suggests that one of the potentially most fruitful places to prospect for artefact scatters will be the zone between the edges of deposits mapped as Clay-with-flints and the escarpment edge. Potentially, however, primary context sites further onto the plateaux, perhaps equally favoured by early humans, could still be buried under dense Clay-with-flints.

The clear link between findspot density and Clay-with-flints survival means that a comparatively sparse archaeological record need not necessarily indicate that Lower- Middle Palaeolithic people were absent from an area. Instead, it could indicate substantial release and subsequent loss of artefacts due to periglacial processes or continuing preservation of artefacts within dense areas of Clay-with-flints.

There are limitations to the data used in my research and these must be acknowledged when considering my mapping of findspot geological context. Firstly, the British Geological Survey does not map superficial deposits <3m deep and when ground-truthing deposits such as Clay-with-flints they often cover a bigger area than is suggested by BGS mapping (*pers. com.* D. Garton 22nd May 2016). However, the unmapped areas consist of precisely the thinner Clay-with-flints deposits within which my working hypothesis predicts optimal conditions for erosional artefact release and recovery. Secondly, despite the superb resource for British Lower-Middle Palaeolithic archaeologists constituted by the SRPP and TERPP datasets, there are some limitations to the data. Many of the older findspots, constituting the bulk of the British data, have only a general (G) NGR - i.e. accurate to parish or district level. Nevertheless, my distribution mapping has shown that most findspots (~75% on the South Downs and ~80% on the North Downs and Chilterns) lie well within the boundaries of the Clay-with-flints, meaning that at a landscape scale the mapping of even 'G'- classfied findspots to their geological context remains informative. This means that neither limitation invalidates my methodology or my results.

Geomorphology has also played a major role in the difference between the British and French Lower-Middle Palaeolithic archaeological records. I was unable to carry out such detailed analyses of the relationship between % Clay-with-flints survival and findspot density and distribution in northern France because of a fundamental geomorphological difference between the

Chalklands there and in southeast Britain. The continuous, primarily Weichselian Loess belt of northwest Europe can be up to 10m (33ft) thick in northern France (Clarke *et al.* 2007; Haase *et al*. 2007). Because of this deep loess cover, only extreme human intervention will release the archaeology of the French Chalklands. Otherwise, preservation prevails. In southeast Britain, where much greater erosion has occurred, release has frequently taken place without human intervention. Surface/chance finds constitute 37.8% of my English Chalk uplands dataset but only 0.6% of my French sites and even that single find was made by Vignard during his observation of the construction of the Canal du Nord.

The deposition and survival of deep loess has protected and preserved French primary context Middle Palaeolithic archaeology on a large scale, while rendering it invisible. At Etricourt-Manancourt (Somme) for example, five separate primary context Lower and Middle Palaeolithic occupation layers have been excavated, dating from 330,000 – 70,000 ka (Hérisson *et al.* 2016b).

In sharp contrast, Britain's position on the extreme western edge of the European loess belt means British deposits were never as thick as those in France and now survive primarily in thin patches, generally <1m thick (Goudie 1990). Isolated deposits of older (pre-MIS5) loess do occur but, as in France, most deposits are MIS2-MIS4 (Burrin and Scaife 1984; Catt 1977; Goudie 1980). The wholesale removal of Britain's thinner loess cover, except in solution hollows or other sheltered spots, means that primary context preservation is rare in England but surface archaeology is highly visible. The generally accepted absence of humans from Britain between MIS4 and MIS6, at a time when there was significant colonisation in neighbouring France could, in reality, be due to the lack of a suitable sedimentary matrix to bury and preserve the archaeology from that period. The rarity of even MIS2 to MIS4 loess survival means that archaeological evidence of human presence in Britain between MIS6 and MIS 3, if it survives at all, is likely to be vanishingly rare.

There are significant differences in the presence of potentially archaeology-rich solution features (dolines) between my three core study areas. Derived from the Slavonic *dolina* meaning valley (Kaufmann 2014) the term 'doline', is used chiefly by geomorphologists on the continent of Europe, whereas

the term ‘sinkhole’ is used in the USA and in engineering for the same phenomenon (Williams 2004). Ninety-seven percent of dolines occur where there is a ‘cover deposit’ over the Chalk and usually within 200m (656ft) of that ‘cover deposit’ margin (McDowell *et al*. 2008; Worsley 2016). They are concentrated on flat hilltops between or adjacent to river valleys (Wu *et al.* 2016). The large-scale preventive archaeology carried out in France on open-air sites that would be destroyed during infrastructure development has shown the potential that exists for primary context archaeological preservation in dolines. Remarkable examples include the several stratified levels of Middle Palaeolithic occupation discovered at Bettencourt-Saint-Ouen “La Queue de la Fôret” during the building of the Autoroute A16, the undisturbed MIS9 level discovered at Clairy-Saulchoix “Au Chemin de Pissy”, the plateau-edge doline site of Gentelles “Mont de l’Evangile” which occupies an area more than one kilometre in extent and the rare evidence for Late Middle Palaeolithic (40-50ka) occupation in northern France preserved at Gauville “Bout de la Route du Bois”. The last three were all discovered during preventive archaeology associated with the construction of the A29 Ouest.

Relatively high concentrations of dolines occur in the London Basin, where Paleogene deposits are most extensive and erosion surfaces best preserved. Recorded densities are low where superficial deposits are generally thin and erosion surfaces relatively poorly preserved due to dissection, as on the South Downs (Jones 1999a; Sperling et al. 1977). On the eastern North Downs doline density is between 51and 70 per 100km^2/38.6mi^2, on the Surrey North Downs it is >71 per 100km^2 /38.6mi^2 and on the Chiltern hills it is between 11 and 30 per 100km^2/38.6mi^2, concentrated in the west (Jones 1999a, Fig.9; Worsley 2016). On the South Downs escarpment, the density of solution features is very low – fewer than 5 to 10 per 100km^2 /38.6mi^2. The likelihood of finding primary context Pleistocene deposits, including Lower-Middle Palaeolithic archaeology, preserved in solution features is therefore substantially higher on the North Downs or Chilterns than on the Sussex Downs, although occasional preservation in pre-existing periglacial fissures and gulls may occur on the latter (Collcutt 2001).

Given the topographic specificity of most doline locations (McDowell *et al*. 2008; Worsley 2016; Wu *et al.* 2016) and an understanding of their

formation processes it should be possible to focus on areas of the Chalk plateaux with the greatest potential for dolines and, thus, for finding primary context Palaeolithic archaeology.

Late 19th/early 20th century industrialisation

Having established the dominant role played by geomorphology in the formation of the archaeological record, I looked next at the extent to which late 19th/early 20th century industrialisation had impacted on the opportunities for artefact preservation and/or release in each of my study areas. The core resource for the Palaeolithic is *all* Pleistocene deposits (Wenban-Smith *et al.* 2007,40) and, given that the processes of that industrialisation exposed huge expanses of Pleistocene deposits, notably glacio-fluvial gravels and brickearth, it was inevitable that the consequent release of artefacts into the archaeological record would also have significant implications for Lower- Middle Palaeolithic findspot distribution.

In total, 26.8% of the entries in my English Chalklands Lower-Middle Palaeolithic dataset are attributable to Victorian processes of aggregates and brickearth extraction, railway construction, urbanisation and infrastructure development. In France, the figure is 64%, thanks not only to differences in geomorphology but also to official Government policy and strategies with respect to heritage management and archaeology.

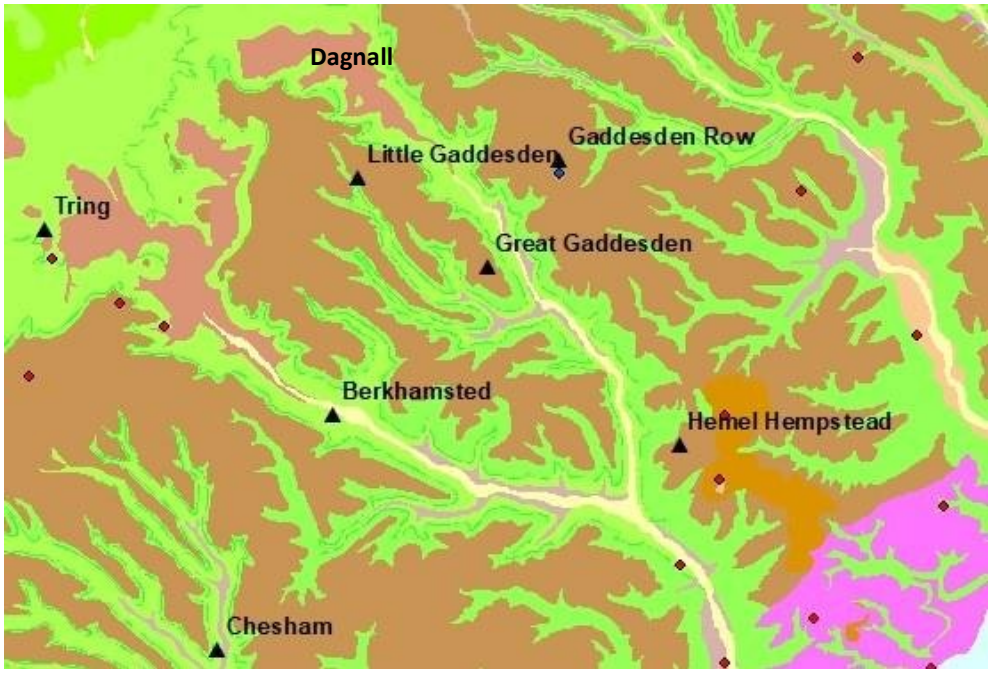
By far the most influential of the industrialisation processes was the quarrying for aggregates and brickearth, particularly the archaeologically rich higher-level Middle Pleistocene terrace gravels exploited during this period. In total, 21.3% of my English and 25.7% of my French dataset entries are attributed to gravel and brickearth extraction, although distribution of these extraction industries was patchy. Of my 378 dataset entries attributable to gravel and brickearth extraction, only 19 are from Sussex, with a further 71 from the Hampshire stretch of the South Downs. The comparable figures are 181 for the Chilterns and 107 for the North Downs.

Five of the 9 South Downs interfluves had no gravel pits to which dataset entries are attributed and of the 12 gravel pits between Eastbourne and the river Test only a single one, at Rodmell between the Cuckmere and Ouse, is actually on the Chalk footprint of an interfluve. This compares with three out of seven North Downs interfluves without gravel pits and only one on

the Chilterns. The Chiltern interfluve without gravel/brickearth pits is that between Dagnall and Tring, which is devoid of any Lower or Middle Palaeolithic archaeology because of its land use history and topography (*cf.* Chapter Six, page 232).

In carrying out my analyses it became clear that a particular topographical configuration was affecting the results for the Tring to Dagnall interfluve. The river Gade rises northeast of the interfluve, from a spring in the Dagnall Gap and runs south to Hemel Hempstead. Its sole tributary, the river Bulbourne, rises just inside the Tring gap and also runs south, joining the Gade near Hemel Hempstead. The combined Gade then continues down the dipslope to Rickmansworth where it joins the river Colne, a tributary of the Thames. Beyond the confluence of the Gade and Bulbourne there is thus only a single river valley running down the dipslope, which from that point on is shared by the Dunstable to Dagnall and Tring to Wendover interfluves with thirty-one findspots between them. The Tring to Dagnall interfluve has, in effect, no dipslope (*cf.* Map 10.1) so lacks the finds attributed to all other interfluves.

Map 10.1 Topographic configuration of the Dagnall to Tring interfluve.



(Geological Map Data BGS©UKRI 2019). For geology legend see following page.

Geology legend

ew238_aylesbury_superficial
LEX_RCS_I

ALV-XCZSV	*ALLUVIUM - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
LOFT-DMTN	*LOWESTOFT FORMATION - DIAMICTON*
GCGR-XSV	*GERRARDS CROSS GRAVEL - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
GFDMP-XSV	*GLACIOFLUVIAL DEPOSITS, MID PLEISTOCENE - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
CWGR-XSV	*CHORLEYWOOD GRAVEL FORMATION - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
KGCA-XSV	*KESGRAVE CATCHMENT SUBGROUP - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
PRSG-XSV	*PRINCES RISBOROUGH SAND AND GRAVEL - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-V	*HEAD - GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XCZ	*HEAD - CLAY AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD-XCZSV	*HEAD - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
HEAD1-XCZSV	*HEAD, 1 - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD1-XSV	*RIVER TERRACE DEPOSITS, 1 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTD2-XSV	*RIVER TERRACE DEPOSITS, 2 - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
RTDU-XSV	*RIVER TERRACE DEPOSITS (UNDIFFERENTIATED) - SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
CWF-XCZSV	*CLAY-WITH-FLINTS FORMATION - CLAY, SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*

ew238_aylesbury_bedrock
LEX_RCS_I

LC-CLSISA	*LONDON CLAY FORMATION - CLAY, SILT AND SAND*
LMBE-CLSISA	*LAMBETH GROUP - CLAY, SILT AND SAND*
CKR-CHLK	*CHALK ROCK MEMBER - CHALK*
LECH-CHLK	*LEWES NODULAR CHALK FORMATION - CHALK*
LESE-CHLK	*LEWES NODULAR CHALK FORMATION AND SEAFORD CHALK FORMATION (UNDIFFERENTIATED) - CHALK*
NPCH-CHLK	*NEW PIT CHALK FORMATION - CHALK*
GLML-GLSST	*GLAUCONITIC MARL MEMBER - SANDSTONE, GLAUCONITIC*
HNCK-CHLK	*HOLYWELL NODULAR CHALK FORMATION AND NEW PIT CHALK FORMATION (UNDIFFERENTIATED) - CHALK*
MR-CHLK	*MELBOURN ROCK MEMBER - CHALK*
WZCK-CHLK	*WEST MELBURY MARLY CHALK FORMATION AND ZIG ZAG CHALK FORMATION (UNDIFFERENTIATED) - CHALK*
ZZCH-CHLK	*ZIG ZAG CHALK FORMATION - CHALK*
GLT-MDST	*GAULT FORMATION - MUDSTONE*
GUGS-MDSS	*GAULT FORMATION AND UPPER GREENSAND FORMATION (UNDIFFERENTIATED) - MUDSTONE, SILTSTONE AND SANDSTONE*
UGS-SISD	*UPPER GREENSAND FORMATION - SILTSTONE AND SANDSTONE*
PB-LMAR	*PURBECK GROUP - LIMESTONE AND [SUBEQUAL/SUBORDINATE] ARGILLACEOUS ROCKS, INTERBEDDED*
PL-LMCS	*PORTLAND GROUP - LIMESTONE AND CALCAREOUS SANDSTONE*
POSA-LMCS	*PORTLAND SAND FORMATION - LIMESTONE AND CALCAREOUS SANDSTONE*
POST-LMST	*PORTLAND STONE FORMATION - LIMESTONE*
KC-MDST	*KIMMERIDGE CLAY FORMATION - MUDSTONE*

This is the only place in my core study areas where this particular topographic configuration occurs and in this instance I have identified sufficient other causes for the lack of findspots to be able to substantiate my results. There is, however, clearly a methodological constraint where this particular landscape configuration is encountered and this must be taken into account when interpreting the data. Other Chalk and soft rock regions may occasionally produce different topographic configurations with a similar impact on analyses of findspot distribution patterns.

The highest number of gravel pits on a single interfluve was 54 on the Princes Risborough to Goring interfluve in the Chilterns, all but 9 of them on the Chalk footprint. The next highest number was 11 on the Luton to Dunstable interfluve, all on the Chalk footprint. However, by far the densest concentration was the 9 pits in the Swanscombe area of the Medway-Darent interfluve where, as quarrying extended inland, a substantial overburden of Pleistocene deposits had to be removed to reach the Chalk,

exposing vast areas of archaeological potential. As a result, the area of the Lower Thames Valley between Crayford and Northfleet is the richest and best-known area of Britain for Palaeolithic archaeology (Wymer 1999, 67). The plateau above the Chalk dipslope there has also proved a rich collecting ground, for Benjamin Harrison and others. Clearly, early human use of the landscape in that area was not confined to the river valley. Rather, they were using the resources of the whole countryside.

As well as stimulating a huge demand for aggregates and brickmaking clay, late Victorian urbanisation - within which I included the building of infrastructure, roads, canals, trenches for utility pipes, commercial and domestic building development - also revealed substantial sections of Pleistocene deposits in deep cuttings and sections..

In total 5.5% of my English dataset entries are attributable to urbanisation processes. As with aggregates and brickearth extraction, however, the impact was patchy and once again it was the South Downs which were largely bypassed (Table 9.6). Five of the nine South Downs interfluves have no urbanisation findspots. By comparison, only two of the eight Chiltern interfluves have none (again, including Dagnall to Tring), while for the North Downs only the Wey to Blackwater Lodden interfluve has none.

With the exception of the Eastbourne to Cuckmere interfluve in Sussex, (Eastbourne's population was 43,300 in 1901) the towns nearest to the other interfluves without urbanisation dataset entries were still relatively small at the end of the Victorian era. On the Cuckmere to Ouse interfluve, Lewes had a population of only 11,000 in 1901. For the Wey to Blackwater Loddon interfluve on the North Downs, the population of Godalming was only 8,748 at that date and the populations of the towns nearest to the Chiltern interfluves of Dunstable to Dagnall and Dagnall to Tring were 11,300 and 6,371 respectively. In Hampshire, the nearest town to the Meon to Itchen interfluve is Winchester, which had a larger population (20,900) in 1901. For the other two Hampshire interfluves without urbanisation findspots (Ems to Meon and Itchen to Test) none of the numerous finds from their nearest towns of Portsmouth and Southampton (1901 populations of 188,100 and 104,800 respectively) are attributable to urbanisation processes.

Despite the enormous scale of its construction, only 18 (1.1%) of the 1772 dataset entries in my core study areas can be attributed to work on railway construction and maintenance and of these only 14 lie within the Chalk footprint of an interfluve. The Chiltern interfluves of Lilley Bottom to Luton, Tring to Wendover and Princes Risborough to Goring between them account for six entries and in Kent, the Great Stour to Medway and Medway to Darent interfluves each account for four. However, only the six Chilterns entries are attributable to the late 19th/early 20th century construction of the public railway network. Construction of the railways did not contribute a single entry to the archaeological record of the South Downs.

It is clear that industrial and infrastructure development in an area impacted greatly on artefact preservation/release opportunities and, consequently, on its findspot distribution patterns. Where there was significant gravel or brickearth extraction as, for example, on the Luton to Dunstable interfluve in the Chilterns, finds density is high even when the nearest centre of population was small. It is highest, however, when a large centre of population and significant gravel and brickearth extraction coincide, as on the Darent to Merstham interfluve in the Thames Valley or between Princes Risborough and Goring in the south Chilterns. Conversely, where neither of these factors was operative then findspot density is low, something that interpretations of human landscape preference based on findspot distribution patterns must into account.

Antiquarian collecting

At least 3,000 places in Britain have produced palaeoliths, from an individual specimen to many thousands. Relatively few of these really deserve the term ‘site’ in the sense of yielding useful evidence relating to Palaeolithic settlement, beyond the presence of lithic artefacts. Perhaps a dozen in total were, or might have been, substantial primary context finds of national importance but were discovered too early for their potential to be realised (White and Pettitt 2011; Roe 1981; Wymer 1968, 3). Nevertheless, had they not been discovered before being destroyed by Victorian industrialisation, primary context sites such as Bakers Hole, Stoneham’s Pit and the Caddington Cottages site would have vanished without trace.

In the century between 1860 and 1960, individual collectors amassed artefact collections that account for ~78% of the handaxes and 85% of known British Lower-Middle Palaeolithic finds locations. The bulk of these were collected in the late 19th/early 20th centuries, during the heyday of gravel-digging by hand. These old collections result from the work of 425 collectors of whom the majority (69%) contributed fewer than ten artefacts each. Only 40 collectors, most of whom had good collecting practices, had a hundred or more artefacts and they contributed 90% of the archaeological record (Harris *et al.* 2019). It was, therefore, necessary to consider in detail the extent to which the activities of individual collectors have impacted on the creation of findspot distribution patterns in that record.

Worthington George Smith, Llewellyn Treacher and Benjamin Harrison were 3 of the aforementioned 40 large-scale collectors, all of whom were active on the Chalk uplands of the Chilterns or North Downs. Analysing the number of dataset entries for which they were responsible revealed their potentially distorting effect on the findspot distribution maps in their respective collecting areas (Maps 9.3, 9.4 and 9.5). There were no individual collectors active on the same scale on the Chalk of the South Downs.

Worthington Smith collected primarily on the North Chilterns between Luton and the Dagnall gap (Map 9.3) although he also obtained artefacts from fellow collectors in other areas. As well as his major contribution to the archaeological record as a result of discovering 4 nationally significant, primary context sites (3 in the Chilterns and 1 at Stoke Newington), Smith was responsible for 33 of my north Chiltern dataset entries. That is 20.8% of the total findspots on the Chalk footprint of the interfluves or 17.7% of all north Chiltern dataset entries, both on and off the Chalk. On an equally large scale, though without Smith's meticulous collecting and recording practices, in the South Chilterns Llewellyn Treacher concentrated his activities on the gravel pits on the Chalk dipslope in the Reading and Maidenhead areas. He was responsible for 67 (17%) of the findspots on the Princes Risborough-Goring interfluve (map 9.4), a further 15 (3.8%) being contributed by his fellow-collector G.W. Smith.

On the North Downs, Benjamin Harrison's impact on the number of findspots mapped onto a single interfluve was even more substantial. Of

the 40 Harrison sites included in my dataset, 33 were from the Medway-Darent interfluve of the North Downs and of 37 findspots mapped onto the actual plateau of that interfluve 22 (59%) were collected by Harrison. A further 22 findspots mapped onto the dipslope of the Medway-Darent interfluve result from cumulative, rather than individual collecting activities. From the 1880s onwards, 45 individuals were collecting in the quarries at Swanscombe, including those like Henry Stopes who were collecting on a massive scale. Twenty-nine of the 45 were collecting in the Barnfield Pit/Milton Street Pit alone (Harris *et al.* 2019). Between them these collectors amassed a total of 10,392 artefacts, including 2,325 handaxes and 8066 flakes and cores but only a single Levallois artefact (Harris *et al.* 2019). By comparison, the 23 collectors active at Baker's Hole, Northfleet from the 1900s acquired only 57 handaxes but 358 Levallois artefacts plus 1,347 cores and flakes. The result of all this collecting was the creation of a supersite, as defined by Ashton and Hosfield (2010) – *i.e.* a site contributing at least 10% of the handaxes from a local study area.

Amateur collecting has dwindled since the mid-20th century, thanks to the full mechanisation of quarrying, the decline of the leisured classes and the growth of archaeology as a formal discipline. Despite this, localised amateur collecting has still, on occasion, the ability to skew the archaeological record. On the North Downs, for example, the activities of Surrey Archaeology Society have contributed 42% of the findspots on the Darent – Merstham interfluve. In the Chilterns, amateur fieldwalking has been responsible for 85% of the finds mapped between the Chalk escarpment and the Thames on the Princes Risborough – Goring interfluve.

The very substantial percentage of the archaeological record created as a result of antiquarian and, to a lesser extent, modern collecting demonstrates that collector contribution cannot safely be ignored when interpreting findspot distribution maps. For any area of the landscape, the number of collectors and the scale of their contribution to the archaeological record must be identified and taken into account as part of any attempt to reach a meaningful interpretation of findspot distribution patterns in that area.

Differences in Government policy and research strategies

The substantial differences between British and French Government policy and research strategies I identified in Chapter Eight have resulted in similarly substantial differences in the shape of the Lower-Middle Palaeolithic archaeological records of the two countries. This has been exacerbated by the geomorphological difference between them, with deep and widespread surviving loess coverage overlying the archaeology in France but almost non-existent in England.

Only 141 (7.9%) of my total English dataset entries are attributable to archaeological fieldwork, more than a third of them the result of amateur activity. Even the Kent fieldwork figure of 13%, enhanced by large-scale, nationally funded infrastructure and research projects, compares unfavourably with France where 59.3% of my 167 dataset entries are attributable to Government/State ordered professional fieldwork. In England, 65.8% (497) of my dataset entries are recorded as chance or surface finds or have no recorded provenance. In France there is only a single example of a chance find and only 17.4% of French entries have no recorded provenance.

Although the difference between the number of English and French entries attributed to gravel and brickearth extraction is insignificant (21.3% and 25.7% respectively) 12% of the French gravel and brickearth extraction sites identified during the late 19th/early 20th centuries have continued to be routinely the subject of watching briefs and archaeological diagnostics. In England the figure is miniscule (0.17%).

The impact of the very different French and English Government policies and practices is clearest in respect of the number of entries attributed to infrastructure and urbanisation. Proactive French Government policy and the use of diagnostics and preventive archaeology in advance of infrastructure construction has meant that 46.1% of French dataset entries are attributable to those processes, nearly 40% of them as a result of road and canal construction. In England the overall percentage is 5.5%, of which only 1.1% can be attributed to road construction/repair.

Although the Pleistocene/Holocene geomorphological histories of the southeast British and northern French Chalklands have been broadly the same, the different degree of protective loess survival in the two countries

means there are substantial differences in their archaeological findspot distribution patterns, as well as in the opportunities for the survival of large-scale primary context archaeology. The very different levels of Central Government interest and involvement in the nation's archaeological resource have had an equally profound effect on the creation and shape of the archaeological records of the two countries and will continue to do so for at least the foreseeable future. This must be borne in mind when attempting to use French and English distribution patterns to compare early human landscape use across the two.

iii) The palaeoenvironmental context of the Chalk uplands

If we are to argue that the Chalk uplands were not marginal for early humans but formed an important part of their total landscape then we must consider the environmental conditions under which those uplands would have been occupied. Modern bioclimate studies draw on a wide range of evidence including malacology, palynology, botany, entomology, palaeozoology and sedimentological data. Modern (early Holocene) pollen assemblages and fossil insect and mammal fauna have also been used to try and establish the nature of Middle Pleistocene environments (e.g. Bakker *et al.* 2016; Mitchell 2005; Svenning 2002; Whitehouse and Smith 2004) although their use depends on an assumption that the ecological tolerances of species have not changed through time (Birks 2005).

There were some major differences between the glacial/interglacial cycles, with extreme interglacials at MIS11, MIS9 and MIS5e, when an oceanic climate predominated. Three warm events occurred during MIS7 (MIS7e, 7c and 7a) interrupted by cold stages MIS7d and 7b (Pettitt and White 2012). Similarly, the cold maxima of MIS9.2, MIS8.6 and MIS 8.4 were much less severe than those of MIS12, MIS10 and MIS6. However, despite differences in detail between interglacials (McNab 2007), the common interglacial vegetation sequence in northwest Europe ran broadly from pre-temperate birch-pine forest, through early temperate deciduous forest to late temperate mixed deciduous-coniferous forest and back to post temperate birch-pine forest. Open interglacial woodland included alder, pine, hazel, hornbeam, oak, spruce, birch, maple and yew (Jones and Keen 1993).

In periglacial Britain average temperatures could range between -20°C and +10°C, fluctuating around 0°C in early and late summer (Williams 1980). In contrast, during the MIS9 interglacial, temperatures ranged between a maximum of +17°C to +26°C and a minimum of -11°C to +13°C (Bridgland *et al.* 2001). There is evidence of the global climate switching from one dominant mode to another within hundreds of years, while temperature changes of up to 10° could happen within a few decades (Lowe and Walker 1997). Animal and plant species would have changed within and between the different stages of each glacial/ interglacial cycle, requiring humans to adapt their behavioural strategies both on the uplands and in the river valleys in order to survive. As the archaeological evidence makes clear, Middle Pleistocene humans did adapt to the different conditions of each glacial/interglacial cycle.

At Boxgrove, Sussex, archaeological remains were found in *in situ* contexts throughout the MIS13 interglacial and possibly into MIS12, demonstrating continuity of occupation over 100,000 years through markedly changing climatic regimes (Roberts *et al.* 1995). During the main period of human occupation the mammalian fauna was dominated by grassland species, including *Stephanorhinus hundsheimensis* and horse, while the presence of mouse, roe deer and wildcat indicate there was woodland or dense scrub nearby, possibly on the Chalk downland above the cliff (Pettitt and White 2012). The majority of species are found in the deciduous and mixed-forest zones of Western Europe today and, based on the ostracod evidence, summers were similar to or slightly warmer than those in contemporary southern England but winters were potentially much colder.

There is an excellent British MIS11 vegetation sequence based on the pollen record from Hoxne, Suffolk. This shows a classic interglacial vegetation succession, with an abundance of forest-floor plants in the mixed oak woodland during the full temperate phase, including geranium, nettles, chickweeds and rosaeaceous shrubs (Pettitt and White 2012). Even at the height of the interglacial this would have been an open woodland, offering plant and animal food resources for humans. Swanscombe, on the North Downs dipslope, has occupation levels spanning a range of climate and environmental conditions throughout much of the MIS11 interglacial. with the mammalian fauna of the Phase I

occupation dominated by animals typical of temperate deciduous or mixed woodland with nearby grassland.

At Red Barns, Portchester the majority of the molluscan taxa from the main archaeological horizon are known from both cold and warm stages, indicating a fairly temperate Chalk grassland. Although the species give no clue as to age, the majority of the amino acid comparisons are with sites attributed to MIS11 to MIS9, such as Cagny-la-Garenne, Somme. The presence of the bones and teeth of the Middle Pleistocene-sized horse *Equus* f*erus,* a specialised open country grazer, is consistent with the grassland conditions indicated by the mollusca. The main archaeological horizon occurred at the end of, or immediately following, a phase of severely cold climate, suggesting correlation with either an interstadial within a glacial period or a short-lived climatic amelioration of interglacial status (Wenban-Smith *et al.* 2000).

Based on OSL dating of sediments and amino acid dating of molluscs, the interfluve site of Harnham, Wiltshire dates to an interstadial in the later part of MIS8, between the cold stages of MIS 8.2 and MIS 8.4 (Bates *et al.* 2014). This demonstrates the ability of humans to survive at this latitude even in the cool conditions of MIS8. The mollusca and small mammalian species found at Harnham indicate grassland and a marshy floodplain with good ground-cover while the few large mammal remains (*Equus ferus* and a large bovid) show the availability of a year-round ready supply of high-quality forage, with little if any deep winter snow-cover (Bates *et al.* 2014).

The encroachment of the mammoth steppe biotope into western Europe from MIS8 enabled a broader use of landscape, in particular of areas further from the rivers (Gamble and Roebroeks 1999; Guthrie 1990; Scott *et al.* 2011). Although few good palaeoenvironmental records exist for the MIS7 interglacial, fossil vertebrates and invertebrates from woodlands and grasslands are preserved at 22 British archaeology sites. The majority of plants found at MIS7 sites, such as Old Bulbourne Quarry, Marsworth, Buckinghamshire still occur in Britain today, implying an MIS7 temperate woodland environment similar to that found in contemporary southern England (Murton *et al.* 2001). Based on beetle evidence from Marsworth, the climatic range was a maximum of +15ºC to +17ºC with a minimum temperature somewhere within the range -9ºC to +1ºC (Murton *et al.* 2001).

Far richer in megafauna than today, the MIS7 river valleys and plateaux would have offered Neanderthals a variety of resources, with a wide range of potential prey and trees and shrubs providing both edible fruits and the materials to make spears and other implements. Many of the herbaceous plants also had edible elements (Pettitt and White 2012).

Early humans were also present in northwest Europe during both fully forested, temperate conditions – e.g. at Caours, Cagny-la-Garenne and Cagny-Cimitière (Somme) – and in subarctic and more continental climatic conditions (Antoine *et al* 2006; Tuffreau and Antoine 1995). At Maastricht-Belvedère, South Limburg malacalogical analyses show human occupation took place in the climatic optimum of the MIS7 interglacial, while Biache-Saint-Vaast (Pas-de-Calais) was occupied at the beginning of MIS6 during cool-temperate or boreal-continental early glacial conditions (Roebroeks *et al.* 1992).

The open downland which today characterises the Chalk slopes did not develop until late in prehistoric times, particularly during the Bronze Age (Waller and Hamilton 1998; Wilkinson 2003). The presumed natural condition of temperate vegetation in northwest Europe is one of primarily closed forest with relatively small open areas, at most impacted locally by large herbivores. (Birks 2005; Sandom *et al.* 2014; Vera 2000; Watt 1947) This 'high-forest' hypothesis has been challenged by Frans Vera, whose 'wood-pasture' hypothesis (Vera 2000; 2002) states that during the early Holocene, large herbivores were the driving force behind a cyclical vegetation dynamic that created a mosaic of open grassland, regenerating scrub and forested groves. This is analogous in many ways to Watt's (1947) classic 'gap-phase' model of cyclical regeneration in the 'high-forest' hypothesis (Birks 2005) which envisages a similar landscape dynamic. Under either hypothesis the interfluves, although heavily wooded, would have had significant areas of open grassland and scrub for large parts of the time and even within an overall interglacial environment the landscape might still have been so diverse that much of it could have been described as open (White 1997; Wymer 1994).

Although Vera applied his hypothesis only to the Holocene, it is likely that similar cyclical vegetation processes occurred during the two Middle and Late Pleistocene interglacials which shared the same humid oceanic

climate as the Holocene (Buckland 2005, 87; Svenning 2002, 134). Contemporary large herbivores have strong effects on the abundance of woody species, plant diversity and other biota, transforming forest towards oak savannah or wood pasture at densities of >25 kg per hectare. Their effect would have been amplified prior to the Late Pleistocene megafaunal extinctions by the presence of a diverse range of megafauna with body weights up to 6,500 kg, including megafaunal browsers of ≥1000kg (Bakker *et al.* 2016). Fragmentary faunal remains from Rackley, Caddington indicate the presence there of megafaunal elephantid and rhinoceros at the time when Smith's Cottages site was occupied (Campbell and Hubbard 1978,56).

From the Middle Pleistocene onwards, humans were present in heavily forested settings inhospitable even for modern hunter-gatherers and during the Late Pleistocene there was occupation of northern Europe in all but the harshest glacial maxima (Roebroeks *et al.* 1992). While the summit plateaux of the Chalk uplands may have been densely wooded at the height of an interglacial, these conditions pertained for only ~8% of the last 700,000 years (Gamble 1995b). Fossil insect evidence implies that many floodplains were actually the most densely forested areas, while many woodland invertebrates require a mosaic landscape, rather than full woodland canopy (Whitehouse and Smith 2004).

Given Britain's oceanic climate, streams would have been abundant in the landscape for much of the Palaeolithic and under those conditions shortage of water would not have been a problem for either humans or animals (Hardaker 2004, 33). Small torrential streams and sheets of water still flow occasionally on the Clay-with-flints *sensu lato* of the Chilterns plateau, albeit usually only for a few hours during and immediately after very heavy rain. This leads to temporary ponds in hollows on the plateau surface or in the heads of shallow dry valleys (Catt 1978, 45) and, if lined with impermeable clays or filled with brickearth with a sufficient clay content to prevent percolation, dolines may form semi-permanent lakes (Catt *et al.* 1978). This means that river valleys need not always have been the focal point for game. Even when dry, the doline margins would have provided raw material from the Chalk and Clay-with-flints (White 1997, 929), making them attractive to early humans.

iv) An uplands-led perspective on Lower – Middle Palaeolithic human landscape use.

There is much on the archaeological distribution maps to refute the suggestion that the Chalk plateaux were used by early humans only under cold conditions and when the river valleys were inaccessible. In the palaeoenvironmental contexts described above, river valleys and the Chalk plateaux would each have had much to offer Middle Pleistocene humans and it seems probable they made full use of both, varying their activities according to season and environmental conditions. The range of food resources on the plateaux may have been more limited than in the valleys but both offered access to large herbivores and a range of edible plants. Prime flint material, including outcropping Chalk and flints from the eroding Clay-with-flints would have been accessible on the plateaux, with flint-rich river gravels available in the valleys. The river valleys would have provided easy access to water, but with the potential danger of flooding and difficulties in crossing rivers and streams under wet conditions. Plateaux sites would have had more restricted access to water, particularly under dry cold conditions, while river valleys would have offered limited visibility compared to the plateaux edge sites with their wide vistas over the valleys below. Upland sites would often have been safer for smaller camps and in a cold, open environment where prey, competitors, predators and collaborators could move very swiftly, good line of sight and long-range audibility would have been more important than the ground tracks needed in woodland (Collcutt 2001).

The archaeological evidence in fact demonstrates that the uplands were used for a variety of purposes, including raw material acquisition, tool-making, hunting and butchery, wood-working, and as look-out stands for monitoring the movement of game in the valleys below. At least some sites on the plateaux appear to have been ‘persistent places’, re-occupied intermittently for the same, or for a variety of different purposes, sometimes over tens of thousands of years (Glaubermann 2016; Tuffreau *et al.* 2008).

Raw material collection and tool-making are two of the primary activities for which there is evidence on the Chalk uplands and it is likely that early humans predominantly collected flint from outcrops along the plateau edges and valley slopes, where they subsequently prepared cores and

fashioned tools for activities to be carried out in the valley bottoms (Kolen *et al.* 1999; Scott 2006; White *et al.* 2006).There are several upland sites at which blocks of raw material have been found – e.g. Caddington, where blocks of tabular flint weighing up to 13.6kg (30lbs) were found, possibly transported from several kilometres to the south (Bradley and Sampson 1978). Some had apparently been tested for flaking during the Palaeolithic (Smith 1984,114). Evidence of raw material testing is also seen at Boxgrove (Pope and Roberts 2005) and at Cagny-la-Garenne 2 (Tuffreau *et al.* 2008). At the handaxe manufacturing site of Wood Hill, Kingsdown flint nodules obtained from the Chalk hillside had been carried up to the plateau for knapping (Scott-Jackson 2000) and the remains of blocks of raw material were found by Vignard at Pont de Catigny (Commont 1916a; Vignard 1957).

There is a clear distinction between upland sites at which tools were produced for use on site and those where artefacts were made but then transported for use elsewhere. An example of the former is the Caddington Cottages site, where all stages of the *châine opératoire* were present (Bradley and Sampson 1978). Examples of upland workshops from which finished artefacts were removed for use elsewhere are Red Barns, Hampshire where there was access to raw material direct from the Chalk (Wenban-Smith *et al.* 2000) and Salouel 'Rue des Moutiers', Somme (Roebroeks *et al.* 1988). Smith's other Chilterns plateau discoveries are examples of sites to which handaxes made elsewhere had been transported for use. At Round Green and Gaddesden Row, for example, numerous handaxes were found despite an almost total lack of débitage (White 1997). Clearly, Middle Pleistocene humans were habitually carrying bifaces made at one site around the plateaux for use elsewhere.

Well-balanced wooden spears found at the MIS9 site of Schöningen, Germany, alongside the butchered remains of approximately 40 *Equus mosbachensis* (Davis and Ashton 2019; Milks *et al.* 2016; Schoch *et al.* 2015) demonstrate that such weapons were used successfully during the Middle Pleistocene to hunt large mammals (Wenban-Smith *et al.*2006). Middle Pleistocene humans could have successfully hunted the large herbivores on the Chalk plateaux, perhaps using spears fashioned on staves from the wooded and shrubby areas. The earliest British evidence for hunting is from Boxgrove, Sussex (Pitts and Roberts 1997) while the

lithic assemblage from the early MIS11 elephant butchery site at Ebbsfleet, ~1km (0.62mi) from Swanscombe, exhibited use-damage reflecting on site tool production and butchery during temperate conditions and with woodland nearby (Wenban-Smith *et al.* 2006). The frequency of bifaces at Whipsnade, Chilterns, together with use-wear damage on two of those bifaces, suggest it was a specialist activity site for carcass dismemberment (White *et al.* 1999). Use-wear analysis of the lithic assemblage from the early MIS5/late MIS6 to earlyMIS7/late MIS8 upland site of Payre, France identified woodworking activity, possibly for the making of spears like those from Schoningen, as well as evidence of large herbivore butchery (cervids, equids and bovids) and hide processing (Hardy and Moncel 2011). Payre sits on a promontory overlooking the Rhone and Payre valleys and was visited repeatedly for short term seasonal occupation at the beginning of interglacial cycles. At the MIS5e plateau site of Mauran, above the Garonne and Volp rivers, the remains of at least hunted 137 bison were found (White *et al.* 2016).

Situated as they often were on narrow interfluves orientated to overlook nearby river- and dry-valleys, the close relationship of many upland sites to those valleys argues for their use as hunting look-out points (Drinkall 2013; Kolen *et al.*1999; Scott-Jackson and Scott-Jackson 2010). During the Middle Pleistocene, river valleys would have been shallower and narrower, especially on the Chalk (Gibbard and Allen 1994). Herbivores using them as corridors through the landscape would more easily and safely have been spotted and their interception planned from plateau-edge sites above, rather than on the narrower floodplains. White *et al.* (2016) suggest that Neanderthals practised the recurrent use of driving and trapping herds using both the topography and the animals own social and avoidance behaviour to their advantage. In closed interglacial forests they could also have stalked and ambushed individual animals. Scott-Jackson and Scott-Jackson (2010) envisage migrating herds being spotted from above, then hunted as the nearby valleys funnelled them into restricted routes or passes, while the horse-hunting site of Schoningen 13 II-4 was located at a narrowing between the lake-shore and the uplands of the Elm, allowing the hunters to force the horses towards the lake-shore (Schoch *et al.* 2015).

A range of other archaeologically less visible or invisible activities, including woodworking and foraging for plants, must also have taken place at upland

sites. As well as the spears, Schöningen produced evidence of other woodworking, including the worked bases of branches that may have been used as hafting implements (Schoch *et al.* 2015). Use-wear damage on a twisted cordate from Westcliffe, on the Kent North Downs, indicated it had been used to chop wood (Parfitt and Halliwell 1996) while use-wear evidence from the promontory site of Payre, France demonstrated both woodworking and the processing of plants, including starchy Underground Storage Organs (Hardy and Moncel 2011).

Although the range would have varied both between and during the different glacial/interglacial cycles, the wooded environments on the Chalk plateaux would have been relatively rich in plant food resources for Middle Pleistocene humans (Thomas 1989, 550). Herbs, berries from thorny shrubs such as blackthorn and nuts such as hazel would have been available as part of the cyclical vegetation regeneration envisaged by both Vera (2002) and Ward (1947). During MIS7, wetland plants growing around water margins included watercress and wild mustards while on the valley sides dry, herb-rich grassland existed alongside stinging nettle and dock on the steepest slopes. Various woodland understorey plants have also been recorded from this interglacial, including hazel and juniper, bracken, ivy, fern, anemone and stitchwort (Pettitt and White 2012).

Analysis of dental calculus from Neanderthal teeth has established that even in cold northwest Europe, Neanderthals made use of divers plant foods available in their local environment (Henry *et al.* 2011; 2014) while Neanderthals from wooded environments have been shown to eat a diet with a higher plant component than those from mixed or open environments (Buck and Stringer 2014). The presence of plants known today for their medicinal qualities in the dental calculus of a Neanderthal from El Sidron, Northern Spain might even suggest that Neanderthals were capable of self-medication (Hardy *et al.* 2012).

Gamble (1996a; 1998) envisaged that Neanderthal landscape use was based on a network of paths and trackways across the countryside. The favourable microclimate of south and south-west facing slopes in river - and dry-valleys on Chalk would have offered appealing dispersal routes across the landscape and as pathways between the resources of the valley bottoms and plateaux. Based on artefact distributions, Commont

interpreted the valley bottom Mousterian gisements in the Catigny area as centres from which people radiated out up the side valleys looking for raw material sources and water (Commont 2016a).

In Chapter Three I considered a number of current interpretative models of landscape use, all virtually ignoring the archaeological record of the Chalk uplands and assuming an early human preference for river valleys. These were Ashton *et al*'s (2006) riparian preference model, Brown *et al*'s (2013) nutritional niche hypothesis, Hosfield's (1998) routed foraging model and Ashton's (1998) static and mobile resource model. In Chapter Three I was concerned with the extent to which each model considered or ignored the potential significance of geomorphology for the archaeological distribution patterns on which they are based. Here, I reconsider those models in light of the results of my research and the perspective on upland/lowland landscape use I have proposed.

The riparian preference model argues that during fully temperate conditions humans would have preferentially targeted river valleys because they were more open than the interfluves and offered a wider range of resources. The interfluves would have been used only during more open, cooler conditions. The model is based entirely on MIS11 river-valley and lake-edge sites and ignores the extensive archaeological record of the Chalk uplands. As my results have shown, 21.3% of the entries in my English Chalklands dataset are attributable to Victorian river gravel and aggregates/brickearth extraction, with a further 5.5% attributable to urbanisation processes. The riparian preference model makes no allowance for the fact that gravel extraction and urbanisation took place primarily in the river valleys, nor does it consider the opportunities for artefact collecting provided as a result of the exposure of artefact-bearing Pleistocene deposits. As I make clear in Chapter Six, artefact density in a unit of landscape is clearly related to the collecting opportunities presented by the intensity of late nineteenth/early twentieth century industrialisation in that unit, challenging the validity of the riparian preference model.

The Nutritional Niche model (Brown *et al.* 2013) states that the marked concentration of the richest, pre-MIS5 sites (those with >500 bifaces) in the lower reaches of river-valleys and at the junction of two or more watercourses, is a real archaeological distribution and not primarily the

result of taphonomy. Based on data from 23 British and French archaeological sites in the Channel region and from 37 British and Northwest European palaeoecological sites, the model argues that overall nutritional diversity and the availability of key micronutrients made river floodplains the optimal location for early humans. However, it ignores the fact that the 'super site phenomenon' is at least partly explicable by geomorphological processes, thanks to the 'dumping' of river sediments and any included artefacts at the point where two rivers meet, owing to the consequent decreased water velocity. River gravels from the steeper Chalk rivers are similarly off-loaded at the junction between the Chalk and Tertiary bedrock (Hosfield 1999). The resulting abundance of fluvial gravels at and below the Chalk/Tertiary bedrock junction was a rich source for Victorian aggregates extraction and for the antiquarian collectors it attracted. Sixty-seven of my dataset entries for the Hampshire South Downs are attributable to gravel extraction (Table 6.1) and the concentration of Palaeolithic findspots around the Romsey area (*cf.* Fig. 4.5) is a consequence of the concentration of gravel pits in this area, including the very rich gravel pits at Dunbridge and Wood Green. The model makes no attempt to assess the basis of the archaeological distribution patterns on which it is predicated and my results with respect to the impact of Victorian aggregates extraction on those patterns call it into serious question.

Based on his analysis of the spatial distribution of Middle Pleistocene archaeology in the Hampshire Basin, Hosfield (1998; 1999) proposed a 'routed foraging' model which argued that early humans favoured selected drainage systems and river valleys. Within spatially limited home ranges, they moved between highly localised foci of activity, revising and exploiting them intermittently over single climatic phases. 'Tethered' to these favoured local areas within riverine landscapes, their repeated foraging included migration routes for herbivores, grazing territories and natural features such as water holes and river crossings. This is, in some respects, a variation of the riparian preference model in that it regards the Chalk plateaux as being an insignificant part of the human landscape and focuses on the river valleys. Hosfield recognised that the distribution patterns visible in Palaeolithic archaeology have been strongly influenced by the distribution of Pleistocene deposits and acknowledged the impact of aggregates extraction and urbanisation. However, the 'routed foraging' model makes

no attempt to establish or allow for the actual extent of that impact. Aggregates extraction and urbanisation between them account for more than a quarter of my entire English dataset and my results clearly show that finds density is highest when a large centre of population and significant Victorian gravel and brickearth extraction coincided. It is lowest when neither factor is present.

Hosfield's 'routed foraging' model accords well with the 'static and mobile resource' model postulated by Ashton (1998) to explain the artefact manufacture and discard patterns at the Lower Palaeolithic site of Barnham, Suffolk. The model, which could explain the existence of apparently favoured places in the landscape, proposes that the presence of static resources such as a water hole or raw material source would result in humans repeatedly visiting a particular place, with a consequent accumulation of artefacts. Mobile resources such as prey animals would lead to a series of single discard events over a wider area, the degree of permanence of a resource directly affecting the amount of discard in any one area (Ashton 2004). Upland examples of the impact of a permanent resource presence can be seen in Worthington Smith's *in situ* sites of Round Green and Caddington, both of which were found by at least semi-permanently ponded dolines.

Given that, as already established, both the river valleys and the Chalk uplands had much to offer Middle Pleistocene humans, the foregoing models are not so much wrong in their detail as in their focus on the river valleys and flood-plains to the exclusion of other areas of the landscape. There is clear archaeological evidence that early humans used the high ground for a wide range of purposes and although there may have been some behavioural differences between upland and lowland areas of the landscape (Drinkall 2013; Kolen *et al*. 1999; Tuffreau *et al.*1997; White *et al.* 2008) this was a matter of degree, rather than kind.

v) Suggestions for future work

During my research I have established some areas of the Chalk upland landscape which have future archaeological potential and some of the issues we must address in order to establish where best to search for Lower-Middle Palaeolithic archaeology in southeast Britain:-

- The apparent distribution of artefacts associated with Clay-with-flints I have identified during my research must be tested to verify its potential to signpost new and possibly significant archaeological sites. Despite the limitations of the BGS mapping of Clay-with-flints acknowledged in Chapter Four (page 124), this could be achieved by a combination of systematic, controlled fieldwalking around the perimeter of the Clay-with-flints deposits mapped by the BGS and those between the edges of the Clay-with-flints and the escarpment edge, where the Clay-with-flints *sensu lato* feathers out. The perimeter of the fragmented Clay-with-flints on the South Downs has a significantly higher overall percentage of finds (26.8%) from the edges of its Clay-with-flints than the North Downs or Chilterns, which have 19.4% and 19.6% respectively (*cf.* Table 9.3). On the Ouse to Adur interfluve 60% of the finds come from the edges of the Clay-with-flints and the figure for the Meon to Itchen interfluve is 50%.These would be the obvious interfluves on which to begin work, followed by the Luton to Dunstable interfluve in the Chilterns, where 34.8% of the finds map around the edges of the Clay-with-flints. Another obvious place to look for archaeological sites would be at the crossroads of natural routes through the landscape, as evidenced by the rich archaeology of the area around Catigny, Oise where four water courses cross (Commont 2016a);
- As I demonstrated in Chapter Nine, the Eastbourne to Cuckmere interfluve of the South Downs has an anomalously high findspot density in relation to its surviving Clay-with-flints deposits (22.73 per 100km^2/38.6mi^2 (*cf.* Table 9.2). This cannot be accounted for by antiquarian collecting activities or late 19th/early 20th century industrialisation processes. Unlike the rest of the Sussex Chalkland, this block of the South Downs is known to be particularly prolific in terms of Palaeolithic surface finds, although very few have a specific provenance (Woodcock 1981, 359). This raises important questions about why this is the case and whether what we see in the archaeological record is, in fact, a true reflection of early human landscape use rather than just the result of variables operating on that record's

creation. The interfluve clearly has significant future potential and sustained fieldwalking of the kind carried out so fruitfully on the Folkestone to Great Stour interfluve of the North Downs by the Dover Archaeological Group (Halliwell and Parfitt 1993; Hoskins 1998; Parfitt and Halliwell 1996; 2002) could identify potential artefact clusters for further investigation and possible excavation;

- The preservational quality of dense Clay-with-flints gives the deposits a high potential for preserving primary context archaeology. Targeted sampling by excavation on those interfluves with the densest surviving Clay-with-flints – e.g. Tring to Wendover in the Chilterns (31.4%), Darent to Merstham (32.81%) and Great Stour to Medway (38.74%), on the North Downs - could prove fruitful, especially where these interfluves coincide with areas of high doline density;
- Dolines have a proven potential to preserve Pleistocene deposits and possibly Lower-Middle Palaeolithic archaeology.The Chalk upland regions with the highest overall levels of doline density have been identified (Edmonds 1983; Jones 1999a) as being the Chiltern Hills (22 per 100km^2/38.6mi^2) and the Kent Downs (47 per 100km^2/38.6mi^2). However, the density figures for a large area may mask the significantly greater densities of sub-areas and vice versa (Edmonds 1893). While the overall Chilterns' solution feature density is 22 per 100km^2/38.6mi^2, more than 1000 of these features lie in the western Chilterns (Worsley 2016). Similarly, on the North Downs in Surrey and West Kent doline density rises to 63 per 100km^2/38.6mi^2. We need, therefore, to establish an accurate database of the location of individual dolines and other localised capture points across the Chalk uplands for targeted investigation. Previously, methods of identifying sinkholes and dolines have been labour-intensive and time-consuming, based primarily on visual interpretation of low-resolution topographic maps and aerial photographs, with subsequent field validation. Now, however, it is possible to use freely available Lidar data to carry out large-scale GIS exercises to map dolines on the plateaux tops. Examples of such free data

are lidarfinder.com (https://www.lidarfinder.com/) and the Department of the Environment's Composite DSM raster elevation model, which covers >60% of England at 1m spatial resolution. Automatic mapping using different resolution LiDAR-derived DTMs has been shown to give reliable results and to be particularly useful for analysing large areas of landscape. In trials it proved capable of successfully identifying previously unknown dolines, known but now infilled dolines, doline boundaries and their morphometric properties. It was also capable of identifying other types of depressions, allowing them to be eliminated from consideration (Wu *et al.* 2016; Zumpano *et al.* 2019). Following identification of areas with significant clusters of dolines, closely targeted ground-truthing could be carried out.

The deep loess covering in France renders these suggestions inappropriate for the French Chalklands. However, French Government policy and diagnostic archaeology are already identifying primary context sites there in significant numbers.

vi) Conclusion

Having identified that geomorphology, industrialisation, antiquarian collecting and government policies have all substantially affected the archaeological distribution patterns visible in our data, we must ask what then are the implications for our use of those patterns as indicators of early human landscape preference?

In this thesis I have attempted to redress the imbalance between the perceived significance of the upland and river valley archaeological records. While it is undeniable that the bulk of British Lower-Middle Palaeolithic archaeology has been found in the river valleys, my research has demonstrated that archaeological distribution maps cannot simply be taken at face value and that where an artefact is discovered does not necessarily indicate where it was made or used. Middle Pleistocene humans were present in Europe in a wide range of environments from ~500ka (Roebroeks 2006; Roebroeks *et al*. 1992a) with intermediate climatic conditions accounting for more than half of the past 700,000 years (Gamble 1986; Gamble 1995b). The Chalk plateaux would have been

readily accessible under such intermediate conditions, especially during the transitional stages from glacial to interglacial and back again, when conditions were relatively warm and tree cover sufficiently sparse to allow clear paths to be established linking plateau sites to the river valley floodplains (Gamble 1986; Stringer and Gamble 1993; Wilkinson 2001; Wymer 1999). Despite this, the advantages of river valleys and floodplains are frequently stressed (Ashton 1998; Ashton *et al* 2006; Ashton and Lewis 2012; Brown *et al.* 2013; Pettitt and White 2012b; Wymer 1999) while the uplands are considered, if at all, as being marginal and supplementary.

Evidence from the French Chalklands has shown that there is abundant primary context Lower-Middle Palaeolithic archaeology on the Chalk plateaux, demonstrating clearly that it was not only the river valleys that were occupied. Ecotonal areas, including the slopes between upland and lowland tracts, are important within the landscape and their movement through time is of major archaeological significance (Bates 1998, 14). Common sense tells us that interfluves and significant slopes, which comprised the greater part of the available land surface, must have been involved in the varied ways in which Palaeolithic people used the landscape (Collcutt 2001). Yet it has been common to dismiss the Chalk upland archaeology as having little to contribute to the debate about early human landscape preference, reinforcing the river valley centred perspective. This binary differentiation between the uplands and lowlands is a modern concept which would have been alien to early humans, for whom the whole landscape was their environment. Instead, we must think of the entire landscape as a single system, its use varying according to different climatic conditions and with each zone having its advantages and disadvantages.

Both uplands and river valleys had much to offer early humans and it is likely they made full use of the Chalk interfluves throughout most of the Middle Pleistocene. The favourable climate of the slopes in river and dry valleys would have offered appealing dispersal routes (Cohen *et al.* 2012; Commont, 1916a; Wymer 1999,46) and when extreme climatic conditions rendered the plateaux inaccessible the same is likely to have been true of the river valleys. Whether ‘high-forest’ or ‘wood-pasture’ there would, for much of the time, have been significant gaps in the vegetation in both zones. Archaeological evidence shows that the interfluves were used intensively for a wide range of purposes including butchering meat killed in

the vicinity, raw material collection and tool-making, wood-working and, no doubt, many other archaeologically invisible activities such as foraging for plants and monitoring of herd movements in the valleys below.

Surface finds constitute >65% of the British Lower-Middle Palaeolithic record of the Chalklands and many finds from hillsides and valley bottoms have soliflucted down from the plateaux. The upland lithic scatters represent a palimpsest of human interaction over generations at one location, proxy data for the ebb and flow of Palaeolithic populations across the landscape and the frequency of visits to a location (Bond 2011). They are a key element to understanding the character of any one regional landscape yet are often disregarded when formulating interpretations of the archaeological record. A better knowledge of the archaeology of the Chalk uplands is essential if a fuller understanding of the record of early human occupation beyond the river valleys is to be achieved (Bailiff *et al.* 2013; Hardaker 2017). Focusing on the archaeology of those valleys and barely acknowledging the presence of the nearby Chalk uplands risks formulating partial and distorted interpretations of early human landscape preference. It is, therefore, imperative that we treat the archaeology of plateau, slope and valley bottom as parts of a single geomorphological and sedimentary system. Only then can we hope to attain a more complete understanding of the British Lower-Middle Palaeolithic.

Gamble (1996b, 64) suggested that if we cannot make immediate sense of secondary context findspots then perhaps we are asking them the wrong questions and analysing them in inappropriate ways. In this thesis I have analysed the Lower-Middle Palaeolithic archaeological record of the cross-Channel Chalklands and related it to the distribution of surviving Pleistocene deposits. I have assessed the extent of bias introduced into the record as a result of geomorphology, Victorian industrialisation, antiquarian artefact collecting and government heritage management policies and strategies. In doing so I have demonstrated the great complexity of the Chalklands archaeological record.

That record may not be a single ‘map’ of where humans discarded things, much less a map of where they used things or where they went. It is, however, a partial image from which inferences can cautiously be drawn about the spatial configuration of landscape use (Isaac 1989, 209). I have

shown that, although not the only influence, geomorphological processes have been the predominant influence on the creation of Isaac's 'partial image' of patterns in the archaeological record because of their relationship to artefact preservation and release. This has led me to my overarching conclusion that patterns in the archaeological record of a region can only properly be understood if the starting point for their interpretation is the geological and geomorphological history of that region.

It must be acknowledged that models are heuristic and that confirmation of observations does not demonstrate the veracity of a model but only supports its probability (Stemerdink *et al.* 2010). Nevertheless, the Lower-Middle Palaeolithic archaeological record is perhaps more appropriately viewed as a series of Middle Pleistocene sediments than a set of Palaeolithic sites (Hosfield 1999,31) and, taken together, my results clearly demonstrate that geological context and geomorphological processes have been the primary influence on findspot distribution patterns in the Chalklands archaeological record. It was the original distribution and survival of the relevant Pleistocene deposits that dictated the location of the aggregates and brickearth extraction industries and their consequent artefact collection opportunities that fundamentally shaped those distribution patterns. Human landscape preference, while important, was only one factor among several.

Any meaningful interpretation of archaeological distribution patterns across the landscape must include identifying the relevant external factors for an area and analysing their impact on those patterns. Although I have been concerned with the archaeology of the cross-Channel Chalklands, my results also have relevance for interpretations of the archaeological records of other regions and other geologies, which will have had their own influencing or distorting factors that must be taken into account.

Because people have too often read distribution patterns in the archaeological record literally and without taking account of that record's complexity, the result has been a partial and unbalanced picture of early human landscape preference. Whilst it may be true that the task of producing an acceptable factual account of how people lived during the Lower-Middle Palaeolithic is actually impossible (Roe 1981, 268) we must nevertheless try. Dividing the landscape into discrete individual units and

looking at the Lower-Middle Palaeolithic data in terms of the different factors involved in its creation in each of those units, rather than considering it only in terms of its spatial distribution across the whole landscape, has allowed me to understand and interpret early human landscape use and preference in a wider, more inclusive way and to establish the circumstances in which findspot distribution really could map human activity and when it does not.

Having considered and ruled out distortion in the findspot distribution pattern as a result of external variables, we may safely conclude that what we are seeing is a real archaeological distribution reflecting early human landscape use.

I have shown that visualising the data in this new way and taking account of all the data, including the upland surface scatters, is essential if we are to arrive at a full and accurate interpretation of early human landscape preference. The mists of time may become increasingly impenetrable with chronological depth (Bouquet-Appel and Degioanni 2013) but provided we acknowledge and take into account the impact on our archaeological data of a range of variables across the whole landscape of an area, especially its geomorphological history, it becomes possible to lift our eyes from the river valleys and arrive at interpretations of early human landscape use that are fully rounded, rather than partial.

Appendix 1. Testing the potential of electrical geophysical survey to locate solution hollows containing primary context deposits: the Bellingdon case study.

i) Introduction

Pleistocene deposits are the core resource for the Palaeolithic. Not all are necessarily significant but all have the potential to be so (Wenban-Smith *et al.* 2007, 40). Palaeoenvironmental records from Middle Pleistocene sites without associated archaeology can demonstrate the range of conditions humans were or were not able to tolerate (Hosfield and Cole 2019) and palaeosol sequences preserved in solution hollows on the Chalk uplands have provided vital information about climate and environmental conditions during the Pleistocene. They have also preserved some of the most important primary context northwest European Pleistocene archaeology yet discovered. Identifying and determining the lateral distribution of buried palaeo-landsurfaces is, therefore, of critical importance in archaeological evaluation of an area as they may represent positions within the stratigraphy at which *in situ* assemblages of material may occur (Bates 1998). To be able reliably to locate such dolines without the need for excavation would have significant archaeological implications.

Bellingdon is a village situated to the north of Chesham on the plateau of the Tring to Wendover interfluve in the Buckinghamshire Chilterns. It lies on similar terrain and geology to key Palaeolithic sites in the region, Worthington Smith's Caddington site offering the closest parallel (Hunn 2011,9). The village, which is arranged along a typical Chiltern ridge, is home to H.G. Matthews Ltd. traditional brickworks.

Abundant deposits of clayey alluvium suitable for brickmaking led to the establishment of numerous brickworks in the Chesham area during the late 19th and early 20th centuries. There were 23 independent brick making companies in Buckinghamshire before the Second World War (*cf.* fig. 6.1), of which H.G. Matthews is now the last survivor. The last traditional brickworks in the Hertfordshire Chilterns,at nearby Bovingdon, closed in 2017 because of inadequate clay supplies.

Established by Henry George Matthews in 1923 and still owned and managed by the Matthews family, traditional techniques are still used at Bellingdon Brickworks today. These include the reintroduction of wood to

fire some of their bricks, a technique phased out in the early 19th century as it was replaced first by coal and then by oil. All of H.G. Matthews' wood-fired bricks are produced by hand.

The clay for H.G. Matthews' bricks is dug from within a few miles of the brickworks, on land owned by the Matthews family. Unique to the Chilterns, it is considered some of the finest brick clay available. It is found in small isolated pockets and requires persistence to find and extract it in a process which is more intuitive than scientific. This has made large-scale brickmaking impossible in the area.

Fig. A.1 Brick-clay stored at H.G. Matthews brickyard

Excavated from one of the fields in which the 2016 survey was conducted.
(Photograph, L. Blundell, August 2018)

In 2007, as part of planning consent for Clay extraction on 4.1 ha. (10.1 acres) of Matthews' land, the Buckinghamshire County Archaeology Service had required that geoarchaeological recording take place, to establish and document the potential of Chiltern Brickearth deposits to preserve archaeological remains and associated palaeo-environmental deposits of Lower Palaeolithic date. Any *in situ* artefact assemblages were to remain buried under an overlying 300mm (11.25in) of unexcavated brickearth. Between July 2007 and May 2011, Archaeological Services Consultancy carried out a sporadic watching brief on a total of 10 individual pits, only 1 of which was adequately observed during trial trenching. The

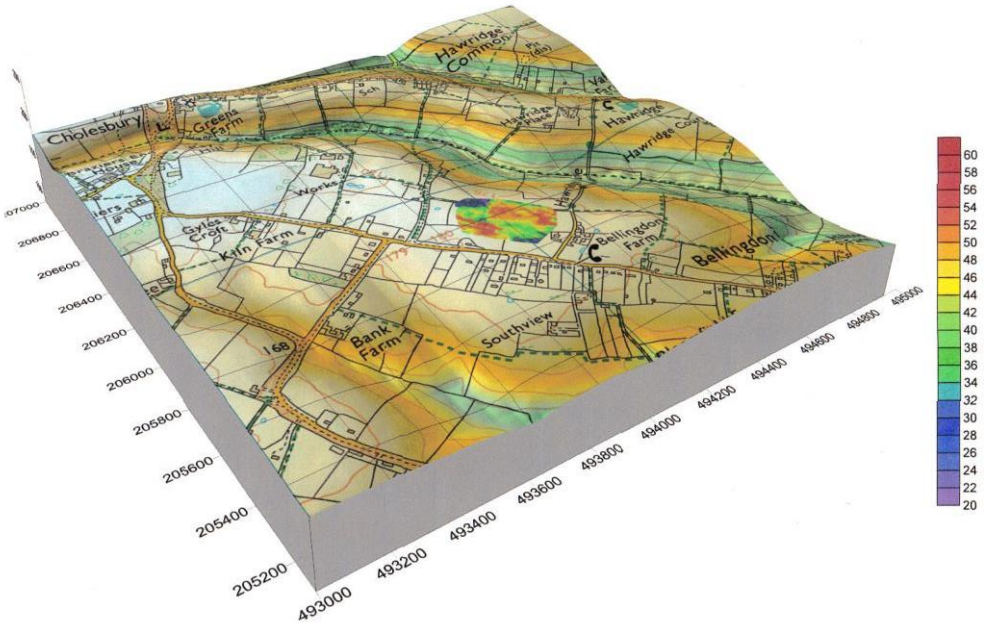
majority of the pits were inspected either during or after excavation was complete. At least one of these had 3m (9.84ft) of standing water in the bottom by the time the archaeologists inspected it (Hunn 2011). There was no geoarchaeologist employed on the watching brief, the project design specifying that one would be called to the site if potential Palaeolithic deposits were identified (Hunn 2007). Perhaps unsurprisingly given its sporadic nature, no evidence of human activity was identified during the watching brief.

In 2015, I approached H.G. Matthews about a possible visit to their brickyard to gain an understanding of the brickearth extraction process and what Clay-with-flints and brick-earth looked like in the field. In October that year I, Dr Matt Pope, Dr Andy Garrard and my geology supervisor, Professor John Catt, were warmly welcomed to Bellingdon where we were privileged to be given a guided tour not only of the brickfields but also of the whole brickmaking process, including brick-making by hand. The works manager, Jim Matthews, who accompanied us that day, was very interested in the geology of his land. He was receptive to the suggestion that electrical geophysical survey methods might be capable of locating dolines containing the brick-clay as this could bring significant commercial advantage for the company.

With Jim Matthews' agreement to the survey being carried out on Matthews land, in 2016 I was awarded a Quaternary Research Association New Researchers Award of £800 to finance the equipment hire and surveying of some 12 ha.(29.6 acres) of farmland at Bellingdon. H.G. Matthews generously contributed substantially towards transport and accommodation costs.

The survey took place over two days in September 2016, in two fields behind the former "Bull" public house and village nursery at Bellingdon, Buckinghamshire (49372 20580). It was conducted by Dr Martin Bates, University of Wales Trinity Saint David's, assisted by one of his colleagues and by me, using a CMD Explorer and a LUND ABEM Terrameter. The intention was to produce maps of the survey areas at two, four and six metres depth of conductivity so that any hollows with deep sediment should show up in plan. No levels were taken before surveying as the fields in question were flat.

Fig. A.2 Terrain map showing location of survey



(Map produced by Dr Matt Pope).

Two different types of electrical geophysical survey were carried out with the intention of testing their potential to locate solution hollows containing *in situ* Middle Pleistocene deposits. These were electromagnetic (EM) and electro-resistance tomography (ERT) survey. Different geological materials (solid bedrock and superficial deposits) show different responses to an applied electrical current and all electrical survey techniques induce electrical currents in the ground to measure the variation in ground conductivity or resistivity. In essence, high conductivity equates to low resistivity. Silts and clays generally show high conductivity and low resistivity while bedrock such as Chalk shows low conductivity and high resistivity.

ii) Electromagnetic (EM) survey (Fig. A 3).

We began by carrying out the EM survey. EM measures ground conductivity at varying depths by the process of electromagnetic induction. The survey equipment consists of a transmitter and receiver coil spaced at a fixed configuration. The transmitting coil outputs a primary electromagnetic field which induces a secondary field in the ground. The receiving coil measures the strength of the secondary field and the ratio between the two fields to establish ground conductivity over the survey

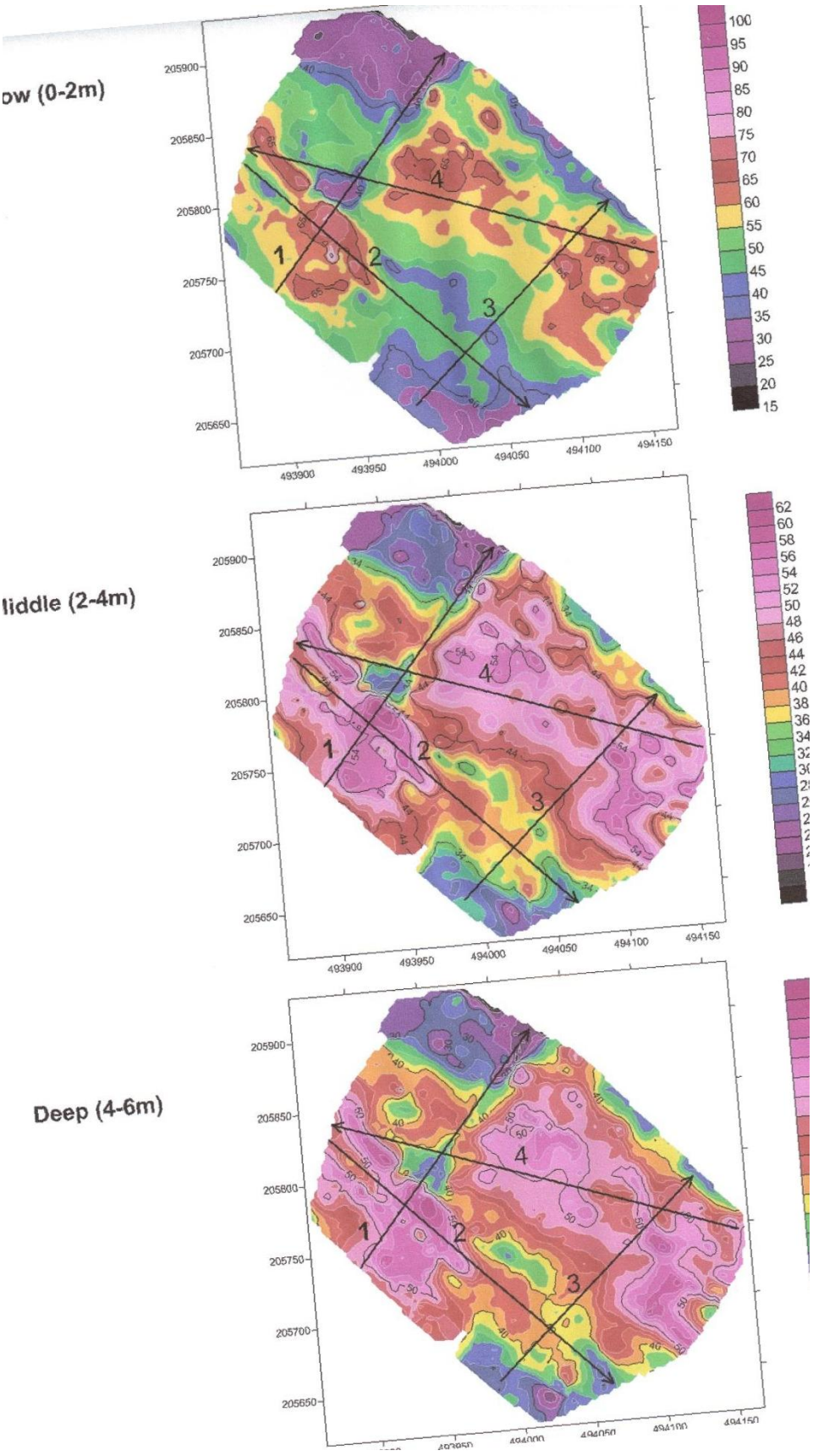
area. The EM data is collected as point readings of ground conductivity taken at regular intervals and recorded on a digital data logger for later downloading to a PC.

Fig. A.3 Collecting point data for the electromagnetic conductivity survey

(Photograph L. Blundell)

The conductivity readings were taken at three depths – shallow (0-2m/6.6ft) middle (2-4m/6.6-13.1ft) and deep (4-6m/13.1-19.7ft) and the results are displayed in Fig. A.4 below. Essentially, the higher the conductivity the potentially thicker the superficial deposits over the Chalk bedrock. For example, looking at the shallow (0-2m/6.6ft depth) plot the red areas are those with the highest conductivity and were therefore expected to be the thickest silts/clays, with the greatest potential for preserved Pleistocene sediments. The green and yellow areas are moderately conductive while the purple areas in the top left and bottom centre are areas of very low conductivity/high resistivity. (When comparing the shallow, middle and deep plots directly with one another the meaning of the colours does not change but the numerical values do). Fig. A.4 shows the layout of the Electro-resistivity Tomography (ERT) survey overlaid onto the EM plot so that the four transects, running across the conductivity plots in the direction of the

Fig. A.4 The results of the EM survey with ERT transects overlaid.



arrows, show the locations of the ERT lines surveyed to test ground resistivity (see above).

iii) Electro-resistivity Tomography (ERT)

ERT measures variations in the electrical resistivity of the ground by applying small electrical currents across rows of ground electrodes. A low frequency current is applied across the outer electrodes and the voltage measured across the inner electrodes. That voltage is converted into a resistivity value representing average ground resistivity between the electrodes. Fig. A.6 displays the results.

Fig. A.5 Setting out the electrodes for the ERT survey.

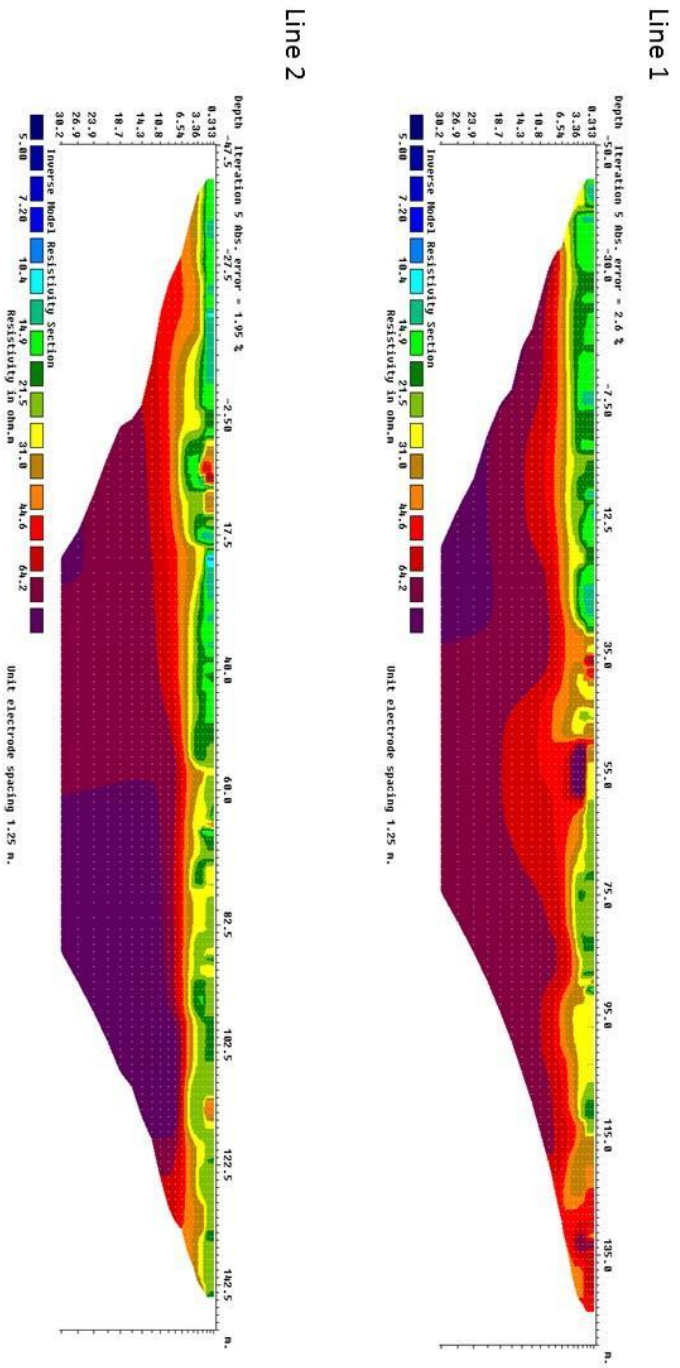
(Photograph L. Blundell).

Line 1 on the resistivity survey results equates to transect 1 on the conductivity plots; Line 2 to transect 2 etc. The lines should be read from left to right in the direction of the transect.

The areas of highest resistivity (shown in reds and purples) were initially interpreted as bedrock and the areas of lowest resistivity (shown in blue or green) as those with the potentially thicker deposits. There appeared to be a relatively thin layer of silts/clays (brickearth), generally between 3m (9.8ft) and 4m (13.1ft) deep but up to 5m (16.4ft) deep in places (e.g. on Line 2), running across most of the site. On Line 1, the red area at the extreme right-hand end was interpreted as Chalk very close to the surface. This

corresponds to the purple area of low conductivity shown in the top left-hand corner of the 0-2 metre EM conductivity plot.

Fig. A.6 The results of the ERT survey.



On Line 2, the small area of high resistivity showing between -2.50 and 17.5 could be the backfill from a former, hand-dug pit in that area. The lower resistivity underlying it was interpreted as deeper deposits still *in situ*. On Line 4, the dark green area of low resistivity at the far right-hand end

corresponds with the area of high conductivity on the extreme left of the conductivity plot.

The results of the two surveys supported one another and appeared, potentially, to identify areas with the deepest surviving silts/clays and, thus, the highest potential for preserving *in situ* Pleistocene sediments. The agreement between the different survey types strongly suggested that electrical geophysical survey does have the ability to locate infilled solution hollows in the Chalk.

iv) Ground-truthing

The EM and ERT surveys revealed differences in ground conductivity and resistivity across the survey area and, based on existing knowledge of the conductivity/resistivity of different lithologies, indicated potentially promising locations for finding *in situ* Pleistocene deposits. The survey results could not, however, identify exactly what deposits were to be found in the different locations, meaning ground-truthing was necessary to get the maximum amount of information from the survey and to confirm the apparent results.

Thanks to the continuing generosity and support of the Matthews family, a group of us, including Dr. Matt Pope and Dr. Beccy Scott of the British Museum, returned to Bellingdon in early March 2017 to ground-truth the survey results while the fields were still clear of crops. H.G. Matthews generously provided their digger and its very experienced driver for the day and the intention was to dig up to nine test pits in the most promising locations across the site. The test pits were to be one digger bucket width, down to a depth of 3-4m (9.8-13.1ft).

In the event, four test pits were dug - mostly in pouring rain – on the areas identified as having the highest conductivity. However, the Plateau Drift on the Chilterns, which overlies the Clay-with-flints *sensu stricto*, can locally be up to 15m deep. They are mapped together as Clay-with-flints by the British Geological Survey and, on the interfluve on which Bellingdon sits, are the densest for any area of the Chilterns. The result was that in three of the pits it was impossible to get down to the level of the Clay-with-flints *sensu stricto* and the Chalk before the digger had to stop for safety reasons.

Fig. A.7 Plateau Drift in Test Pit 1. *The A4 clipboard provides a scale*.

(Photograph L. Blundell).

Fig. A.8 Test Pit 2. *The digger treads can be seen on the left-hand edge of the pit.*

(Photograph L. Blundell).

Fig. A.9 The digger excavating Test Pit 4, corresponding to the red area shown at the extreme right end of Line 1 in the resistivity survey. *The brick clay unexpectedly found in this test pit, can be seen by the digger bucket.*

(Photograph L. Blundell)

In three of the test pits we found Clay-with-flints *sensu lato* in places where the survey results indicated areas of high conductivity/low resistivity. The exception was Test Pit 4 where, in an area of low conductivity/high resistivity we found brick clay instead of Chalk bedrock. These results were the opposite of what had been anticipated.

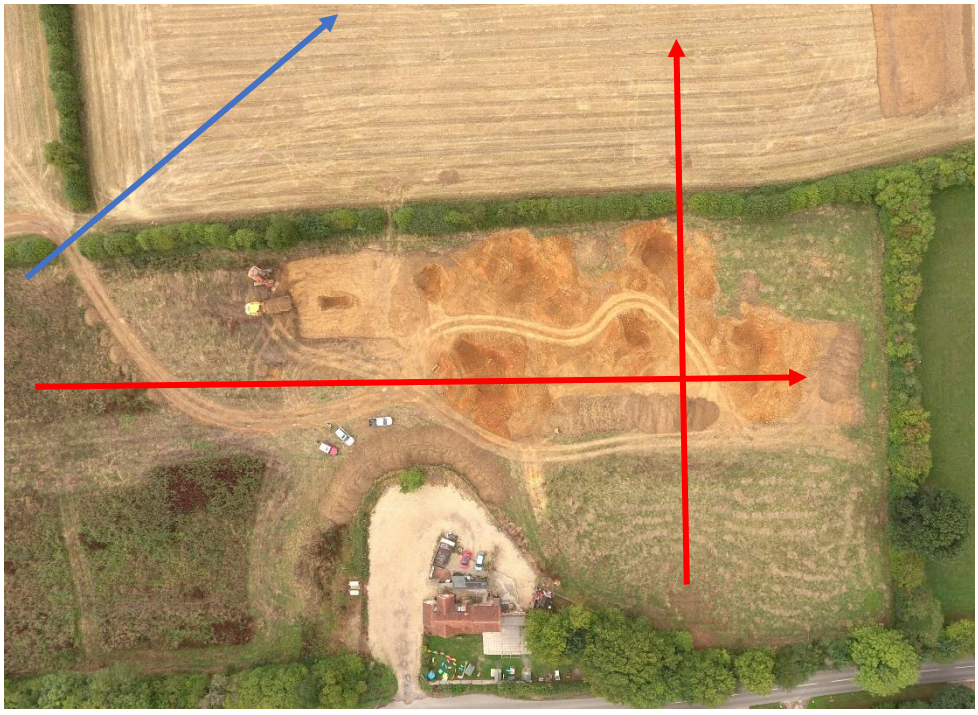
The ground truthing confirmed that EM survey can detect different geological deposits at depth, with the clear differences in the conductivity results matched by the clear differences in the ground. Contrary to expectations, however, the test-pitting results showed that the clay was in fact the least conductive of the deposits and the gravels and clay-with-flints the most conductive. (Dr. Bates, who was not present during the ground-truthing, subsequently suggested this could be because the Clay was so dense it excluded all water).

In summer 2018, having secured planning permission, H.G. Matthews began excavating for brick clay in one of the fields on which we had carried out the survey and ground-truthing. I therefore returned to Bellingdon in August 2018 at Jim Matthews' invitation. The intention was to compare the

Fig. A.10 One of several brick clay extraction pits along transect 2, behind the Bull public house which is visible is in the background.

(Photograph L. Blundell).

Fig. A.11 Drone photograph with overlay of red transect lines 2 (horizontal) and 3 (vertical) of the resistivity survey, as overlaid on the conductivity survey.



The brickearth extraction pits with remnant deposits show up in orange. The second survey field is in the background, with transect 4 (in blue) running diagonally across it. Transect 4 eventually crossed with transects 3 and 1 outside the limits of this photograph. The Bull public house is in the foreground. (Photograph Jamie Matthews).

results of this wider excavation with the original survey and ground truthing and test whether our conclusions about the apparently reversed results were valid. Thanks again to the generosity of Jim Matthews and his nephew it was also possible to take drone photographs of the site (Fig. A.11).

Although only a small portion of the survey area was being excavated at the time of my visit in 2018, the Clay brickearth was distributed broadly in accordance with the initial ground-truthing results – i.e. it was still presenting as areas of lower conductivity and higher resistivity.

v) Conclusion

Together, the results of the survey and ground-truthing exercises show that it is possible to use electrical geophysical survey to identify solution hollows in the Chalk that contain Pleistocene deposits. They also demonstrate the great depth of the deposits mapped as Clay-with-flints on the Tring to Wendover interfluve. This could explain why no finds have been made anywhere on H.G. Matthews' land despite almost 100 years of brickearth extraction and why only a handful of finds have been recorded during brickearth extraction on the entire interfluve.

More testing via survey and ground-truthing is clearly needed but there are, potentially, significant commercial and archaeological benefits from this use of electrical geophysical survey Archaeologically, being able to identify the location of pockets of Pleistocene deposits without prior excavation could facilitate prospection for *in situ* Lower-Middle Palaeolithic archaeology at substantially reduced costs. Commercially, the methodology could provide small independent brickworks like H.G. Matthews with a more scientific way of locating pockets of brick clay. A survey of a field before starting excavation or purchasing additional land for brickearth extraction could indicate where areas of brick clay are most likely to be found or where they are absent. It could allow more promising areas of already-owned land to be targeted and could also avoid the purchase of barren (in terms of brick clay) new land. H.G. Matthews are a significant employer in the Chesham area and increasing their cost-effectiveness would help them to survive and continue to thrive in an area where more than thirty brickworks have closed since 1940. The potential benefit to the local economy is, therefore, substantial. It would also ensure the continuing availability of bespoke

bricks made from local materials for the repair of historic buildings and for new building in the local vernacular.

Bibliography

Abbott, W.J.L. 1911. On the classification of the British Stone Age industries, with some new, little known, well-marked horizons and cultures. *Journal of the Royal Anthropological Institute of Great Britain and Ireland* 41, 458-481.

Abbott, W.J.L. 1924. Chalky boulder marl at Hastings. *Nature* 114 (2861), 312-3.

Aldiss, D.T., Farrant, A.R. & Hopson, P.M. 2012. Geological mapping of the Late Cretaceous Chalk Group of southern England: a specialised application of landform interpretation. *Proceedings of the Geologists' Association* 123, 728-741.

Allaby, M. 2013. *A Dictionary of Geology and Earth Sciences.* (4th edition). Oxford: Oxford University Press.

Allen, L.G. & Gibbard, P.L. 1993. Pleistocene evolution of the Solent River of southern England. *Quaternary Science Reviews* 12, 503-528.

Allen, M.J. 1991. Analysing the landscape: a geographical approach to archaeological problems. In: A.J. Schofield (ed.). *Interpreting artefact scatters: contributions to ploughzone archaeology*. Oxford: Oxbow Monograph 4, 39-57.

Allen, T. 2016. Identifying research aims at the earliest stage of development plans, archaeological curation in England. In: P. Novaković, M. Horňák, M.P. Guermandi, H. Stäuble, P. Depaepe & J-P Demoule (eds.). *Recent developments in preventive archaeology in Europe. Proceedings of the 22nd EEA meeting in Vilnius 2016*. Ljubljana: Ljubljana University of Press, Faculty of Arts,69-90.

Anonymous 1933. Mr. W.J.Lewis Abbott. *Nature* 132(3330), 306.

Annoni, A., Luzet, C., Gubler, E. & Ihde, J. (eds.).2003. *Map projections for Europe.* Ispra, Italy: European Commission Institute for Environment and Sustainability. (https://ec.europa.eu/eurostat/documents/4311134/4366152/Map-projections-EUROPE.pdf). Retrieved on 30 November 2015 from World Wide Web.

Antoine, P. 1990. Chronostratigraphie et environnement du Paléolithique du Bassin de la Somme. Lille: Centre d'Etudes et Recherches Prehhistorique, 231. Publications du Centre d'Etude et Recherches Préhistorique de Lille 2, 231.

Antoine, P. 1994. The Somme valley terrace system (northern France); a model of river response to Quaternary climatic variations since 800,000 BP. *Terra Nova* 6, 453-464.

Antoine, P., Auguste, P., Bahain, J-J., Chaussé, C., Falguères, C., Gahleb, B., Limondin-Lozouet, N., Locht, J-L. & Voinchet, P. 2010. Chronostratigraphy and palaeoenvironments of Acheulean occupations in

Northern France (Somme, Seine and Yonne valleys). *Quaternary International* 223-224, 456-461.

Antoine, P., Bahain, J-J., Auguste, P., Fagnart, J-P., Limondin-Lozouet, N. & Locht, J-L. 2011. Quaternaire et préhistoire dans la vallée de la Somme: 150 ans d'histoire commune. In: A. Hurel & N.Coye (eds.). *Dans l'epaisseur du temps. Archéologues et géologues inventent la préhistoire*. Paris: Muséum National d'Histoire Naturelle, 341-381.

Antoine, P., Coutard, J-P., Gibbard, P., Hallegouet, B., Lautridou, J-P. & Ozouf, J-C. 2003. The Pleistocene rivers of the English Channel region. *Journal of Quaternary Science* 18(3-4), 227-243.

Antoine, P., Catt, J.A., Lautridou, J-P. and Sommé, J., 2003. The loess and coversands of northern France and southern England. *Journal of Quaternary Science* 18(3-4), 309-318.

Antoine, P., Coutard, S., Guerin, G., Deschodt, L. Goval, E., Locht, J-L. & Paris, C. 2016. Upper Pleistocene loess-palaeosol records from northern France in the European context: environmental background and dating of the Middle Palaeolithic. *Quaternary International* http://dx.doi.org/10.1016/j.quaint.2015.11.036. Retrieved on 25 January 2016 from World Wide Web.

Antoine, P., Lautridou, J-P & Laurent, M. 2000. Long-term fluvial archives in NW France: response of the Seine and Somme rivers to tectonic movements, climatic variations and sea-level changes. *Geomorphology* 33, 183-207.

Antoine, P., Lautridou, J-P., Sommé, J., Auguste, P., Auffret, J-P., Baize, S,Clet-Pellerin, M., Coutard, J-P., Dewolf, Y., Dugué, O., Joly, F., Laignel, B., Laurent, M., Lavollé, M., Lebret, P., Lécolle, F., Lefebevre, D., Limondin-Lozouet, N., Munaut, A.V., Ozouf, J C., Quesnel, F. & Didier-Rousseau, D. 1998. Les formations quaternaires de la France du nord-ouest: limites et correlations [The quaternary formations of north-west France: boundaries and correlations]. *Quaternaire* 9(3), 227-241.

Antoine, P., Limondin-Lozouet, N., Auguste, P., Locht, J-L., Galheb, B., Reyss, J-L., Escude, É., Carbonel, P., Mercier, N., Bahain, J-J., Falguères, C. & Voinchet, P. 2006. Le tuf de Caours (Somme, France) : mise en évidence d'une séquence eemienne et d'un site paléolithique associé. *Quaternaire* 17(4), 281-320.

Antoine, P., Limondin-Lozuet, N., Chausse, C., Lautridou, J-P., Pastre, J-F., Auguste, P., Bahain, J-J., Falguères, C. & Ghaleb, B. 2007. Pleistocene fluvial terraces from northern France (Seine, Yonne, Somme): synthesis and new results from the interglacial deposits. *Quaternary Science Reviews* 26, 2701-2723.

Antoine, P., Locht, J-L., Limondin-Lozouet, N., Auguste, P., Bahain, J-J., Fagnart, J-P., Debenham, N. & Ducrocq, T. 2014. Quaternaire et géoarchéologie de la Préhistoire. La modèle de la vallée de la Somme et des régions avoisinantes. In: N. Carcaud & G. Arnaud-Fassetta (eds.). *La géoarchéologie française au XX1^{e} siècle*. Paris: CNRS Éditions, 71-87.

Antoine, P., Moncel, M-H., Locht, J-L., Limondin-Lozuet, N., Auguste, P., Stoetzel, E., Dabkowski, J., Voinchet, P., Bahain, J-J. & Falgueres, C. 2015. Dating the earliest human occupation of western Europe: new evidence from the fluvial terrace system of the Somme basin (northern France). *Quaternary International* 370, 77-99.

Arkell, W.J. 1943-4. Palaeoliths from the Wallingford Fan-Gravels. *Oxoniensia* viii-ix, 1-18.

Ashton, N. 1998. The spatial distribution of the flint artefacts and human behaviour. In: N. Ashton, S.G. Lewis & S. Parfitt (eds.), *Excavations at the Lower Palaeolithic site at East Farm, Barnham, Suffolk 1989-94*. London: British Museum. British Museum Occasional Paper 125, 251-258.

Ashton, N.M. 2002. Absence of humans in Britain during the last interglacial (Oxygen Isotope Stage 5e). In: A. Tuffreau & W. Roebroeks (eds.). *Le dernier interglaciare et les occupations humaines du Paléolithique Moyen.* Lille: Publications du CERP, 93-103.

Ashton, N.M. 2004. The role of refitting in the British Lower Palaeolithic: a time for reflection. In: E.A. Walker, F. Wenban-Smith & F. Healy (eds.), *Lithics in Action: Papers from the Conference 'Lithic studies in the year 2000'*. Oxford: Oxbow Books. Lithic Studies Society Occasional Paper 8, 57-65.

Ashton, N.M. 2008. Transport, curation and resharpening of lithics in the Lower Palaeolithic. *Lithics* 29, 6-17.

Ashton, N. 2016. The human occupation of Britain during the Hoxnian interglacial. *Quaternary International* 409, 41-53.

Ashton, N. 2018. Landscapes of habit and persistent places during MIS11 in Europe. In: M. Pope, J. McNabb, & C. Gamble (eds.). *Crossing the human threshold*. *Dynamic transformation and persistent places during the Middle Pleistocene*. London: Routledge, 142-164.

Ashton, N., Harris, C.E. & Lewis, S.G. 2018. Frontiers and route-ways from Europe: the early Middle Palaeolithic of Britain. *Journal of Quaternary Science* 33(2),194-211.

Ashton, N.& Hosfield, R. 2010. Mapping the human record in the British early Palaeolithic: evidence from the Solent river system. *Journal of Quaternary Science* 25(5), 737-753.

Ashton, N.M. & Lewis, S.G. 2002. Deserted Britain: declining populations in the British late Middle Pleistocene. *Antiquity* 76, 388-396.

Ashton, N.M. & Lewis, S.G. 2012. The environmental contexts of early human occupation of northwest Europe: the British Lower Palaeolithic record. *Quaternary International* 271, 50 - 64

Ashton, N., Lewis, S., Parfitt, S, Candy, I., Keen, D., Kemp, R., Penkman, K., Thomas, G., Whittaker, J. & White, M. 2005. Excavations at the Lower Palaeolithic site at Elveden, Suffolk, UK. *Proceedings of the Prehistoric Society* 71, 1-61.

Ashton, N., Lewis, S.G., Parfitt, S. & White, M. 2006. Riparian landscapes and human habitat preferences during the Hoxnian (MIS11) interglacial. *Journal of Quaternary Science* 21(5), 497-505.

Ashton, N., Lewis, S.G. & Harris, C.R.E. 2015. The distribution of early Palaeolithic sites in Britain. In: N. Ashton & C. Harris (eds.). *No stone unturned. Papers in honour of Roger Jacobi*. Oxford: Oxbow. Lithic Studies Society Occasional Paper 9, 19- 30.

Ashton, N., Lewis, S.G. & Hosfield, R. 2011. Mapping the human record: population change in Britain during the Early Palaeolithic. In: N. Ashton, S.G. Lewis & C. Stringer (eds.). *The ancient human occupation of Britain*. Amsterdam; London: Elsevier. Developments in Quaternary Science 14, 39-51.

Ashton, N., Lewis, S.G., Parfitt, S.A., Davis, R.J. & Stringer, C. 2016. Handaxe and non-handaxe assemblages during Marine Isotope Stage 11 in northern Europe: recent investigations at Barnham, Suffolk, UK. *Journal of Quaternary Science* 31(8), 837-843.

Ashton, N. & Scott, B. 2016. The British Middle Palaeolithic. *Quaternary International* 411, 62-76.

Assadi-Langroudi, A. 2019. A conceptual model for loess in England: principles and application. *Proceedings of the Geologists' Association* 130, 115-125.

Association of Local Authority Archaeological Officers: England 2014. *The future of local government archaeology services*: *response to a request for written evidence*. Retrieved on 21 January 2018 from World Wide Web: www.algao.org.uk/responses

Audouze, F. & Enloe, J.G. 1997. High resolution archaeology at Verberie: limits and interpretations. *World Archaeology* 29(2), High definition archaeology: threads through the past, 195-207.

Auffret, J.P. & Alduc, D. 1977. Ensembles sédimentaires et forms d'érosion du Quaternaire sous-marin de la Manche orientale. *Bulletin de l'Association Française pour l'étude du Quaternaire* 14(4), 71-75.

Avery, B.W., 1964. *The soils and land use of the district around Aylesbury and Hemel Hempstead [sheet 238].* London: H.M.S.O. Agricultural Research Council Memoirs of the Soil Survey of Great Britain, England and Wales.

Bailiff, I.K., Lewis, S.G., Drinkall, H.C. & White, M.J. 2013. Luminescence dating of sediments from a Palaeolithic site associated with a solution feature on the North Downs of Kent, UK. *Quaternary Geochronology* 18, 135-148.

Baker, C.A. & Jones, D.K.C. 1980. Glaciation of the London Basin and its influence on the drainage pattern: a review and appraisal. In: D.K.C. Jones (ed.). *The shaping of southern England.* London: Academic Press. Institute of British Geographers special publication 11,131-175.

Bakker, E.S., Gill, J.L., Johnson, C.N., Vera, F.W.M., Sandom, C.J., Asner, G.P. & Svenning, J-C. 2016. *Proceedings of the National Academy of Sciences of the United States of America* 113(4), 847-855.

Ballantyne, C. K. & Harris, C. 1994. *The Periglaciation of Great Britain*. Cambridge: Cambridge University Press.

Barnes, A.S. 1943. High-angle edge flaking of flint. *Nature* 152 (3860), 477.

Barton, R.N.E., Berridge, P.J., Walker, M.J.C. & Bevins, R.E., 1995. Persistent places in the Mesolithic landscape: an example from the Black Mountain uplands in South Wales. *Proceedings of the Prehistoric Society* 61, 81-116.

Bates, M.R. 1993. Quaternary aminostratigraphy in northwestern France. *Quaternary Science Reviews* 12, 793-809.

Bates, M.R. 1998. Locating and evaluating archaeology below the alluvium: the role of sub-surface stratigraphical modelling. *Lithics* 19, 4-18.

Bates, M.R. 2001. The meeting of the waters: raised beaches and river gravels of the Sussex Coastal Plain/Hampshire Basin. In: F.F. Wenban-Smith & R.T. Hosfield (eds.). *Palaeolithic archaeology of the Solent River*. London: Lithic Studies Society. Lithic Studies Society Occasional Paper 7., 27-45.

Bates, M., Pope, M.I., Shaw, A., Scott, B. & Schwenniger, J-L. 2013. Late Neanderthal occupation in north-west Europe: rediscovery, investigation and dating of a late glacial sediment sequence at the site of La Cotte de Saint Brelade, Jersey. *Journal of Quaternary Science* 28, 647-652.

Bates, M.R., Wenban-Smith, F.F., Bello, S.M., Bridgland, D.R., Buck, L.T., Collins, M.J., Keen, D.H., Leary, J., Parfitt, S.A., Penkman, K., Rhodes, E., Ryssaert, C. & Whittaker, J.E. 2014. Late persistence of the Acheulian in southern Britain in an MIS8 interstadial: evidence from Harnham, Wiltshire. *Quaternary Science Reviews* 102, 159-176.

Bell, A.M. 1884. Palaeolithic remains in Surrey. *The Antiquary* 9, 157.

Bell, A.M. 1894a. Palaeolithic remains at Wolvercote, Oxfordshire. *The Antiquary* 30, 148-152.

Bell, A.M. 1894b. Palaeolithic remains at Wolvercote, Oxfordshire II. *The Antiquary* 30, 192-198.

Bell, A.M. 1894c. Remarks on the flint implements from the Chalk plateau of Kent. *Journal of the Anthropological Institute of Great Britain and Ireland* 23, 266-284.

Bell, A.M. 1898. The tale of the flint. *Longman's Magazine* 31(183), 214-225.

Bell, A.M. 1904. Implementiferous sections at Wolvercote (Oxfordshire). *Quarterly Journal of the Geological Society* 60, 120-132.

Bell, M.1983. Valley sediments as evidence of prehistoric land-use on the South Downs. *Proceedings of the Prehistoric Society* 49, 119-150.

Bellamy, A.G. 1995. Extension of the British landmass: evidence from shelf sediment bodies in the English Channel. In: R.C. Preece (ed.). *Island Britain: a Quaternary perspective*. London: The Geological Society. Geological Society Publication 96, 47-62.

Bennett, K.D. 1995. Insularity and the Quaternary tree and shrub flora of the British Isles. In: R.C. Preece (ed.). *Island Britain: a Quaternary perspective*. London: The Geological Society, 173-180. Geological Society Publication 96.

Beresford, F. 2014. A preliminary note on the Palaeolithic sites in the Upper Ravensbourne area, Bromley, Kent. *Lithics* 35, 54-58.

Beresford, F. 2016 *A re-examination of the late nineteenth century finds in the Upper Cray and Ravensbourne valleys in south-east England, paper prepared for the Unravelling the Palaeolithic Conference, Southampton University,14-16 January 2016.* Retrieved on 13 September 2016 from World Wide Web: https://independent/academia.edu/FrankBeresford.

Beresford, F. 2018. A re-examination of the late nineteenth-century Palaeolithic finds in the Upper Ravensbourne area, Bromley. *Archaeologia Cantiana* 139, 17-45.

Bertran, P., Klaric, L., Lenoble, A., Masson, B. & Vallin, L. 2010. The impact of periglacial processes on Palaeolithic sites: the case of sorted patterned grounds. *Quaternary International* 214, 17-29.

Bertran, P., Andrieux, E., Antoine, P., Coutard, S., Deschodt, L., Gardère, P., Hernandez, M., Legentil, C., Lenoble, A., Liard, A., Mercier, N., Moine, O., Sitzia, L., & Van Vliet-Lanoë, B. 2014. Distribution and chronology of Peistocene permafrost features in France: database and first results. *Boreas* 43, 699-711.

Bertran, P., Liard, M., Sitzia, L. & Tissoux, H. 2016. A map of Pleistocene aeolian deposits in western Europe, with special emphasis on France. *Journal of Quaternary Science* 31(8), 844-856.

Binford, L.R. 1972. Sampling, judgement and the archaeological record. In: J.W. Mueller (ed.). *Sampling and archaeology*. Tucson, Arizona: University of Arizona Press, 251-257.

Birks, H.J.B. 2005. Mind the gap: how open were European primeval forests? *Trends in ecology and evolution* 20(4), 154- 156.

Bisson, M.S. 2000. Nineteenth century tools for twenty-first century archaeology? Why the Middle Palaeolithic typology of François Bordes must be replaced. *Journal of Archaeological Method and Theory* 7(1), 1-48.

Blezer, L., De Loecker, D. & Kolen, J.1996. A Middle Palaeolithic surface scatter at Colmont (Southern Limburg, the Netherlands). *Notae Praehistoricae* 16, 25-36.

Blundell, L. 2016. Hominin activity on the Chalk uplands of southeast Britain: a geomorphological perspective on the archaeological record. *Lithics* 37, 54-64.

Blundell, L. 2017. Testing the potential of electrical geophysical survey to locate dolines containing primary context Middle Pleistocene deposits. *Quaternary Newsletter* 142, 13-16.

Boardman, J. Current erosion on the South Downs: implications for the past. In: M. Bell & J. Boardman (eds.). *Past and present soil erosion. Archaeological and geological perspectives.* Oxford: Oxbow Books. Oxbow Monograph 22, 9-19.

Bocquet-Appel, J-P. & Degioanni, A. 2013. Neanderthal demographic estimates. *Current Anthropology* 54, Supplement 8, S202-S213.

Bocquet-Appel, J-P., Demars, P-Y., Noiret, L. & Dobrowsky, D. 2005. Estimates of Upper Palaeolithic meta-population size in Europe from archaeological data. *Journal of Archaeological Science* 32, 1656-1668.

Boismier, W.A. 1991. The role of research design in surface collection: an example from Broom Hill, Braishfield, Hampshire. In: A.J. Schofield (ed). *Interpreting artefact scatters: contributions to ploughzone archaeology*. Oxford: Oxbow Books. Oxbow Monograph 4, 11-25.

Bond, C.J. 2011. The value, meaning and protection of lithic scatters. *Lithics* 32, 29-48.

Booth, S., Merritt, J. & Rose, J. 2015. Quaternary provinces and domains – a quantitative and qualitative description of British landscape types. *Proceedings of the Geologists' Association* 126, 163-187.

Bordes, F. 1953a. Essai de classification des industries "moustériennes". *Bulletin de la Société Préhistorique de France* 50(7-8), 457- 466.

Bordes, F. 1953b. Levalloisien et Moustérien. *Bulletin de la Société Préhistorique de France* 50(7-8), 226-235.

Bordes, F. 1961. Mousterian cultures in France. *Science* 134(3482), 803-810.

Bordes, F. 1968. *The Old Stone Age*. London: Weidenfeld and Nicolson.

Bordes, F. 1971. Physical evolution and technological evolution in man: a parallelism. *World Archaeology* 3(1), 1-5.

Bordes, F. 1981. Vingt-cinq ans après: le complexe moustérien revisité. *Bulletin de la Société Préhistorique Française* 78(3), 77-87.

Bordes, F. & de Sonneville-Bordes, D. 1970. The significance of variability in Palaeolithic assemblages. *World Archaeology* 2(1), 61-73.

Bovy, B., Braun, J. & Demoulin, A. 2016. A numerical framework of simulating the control of weather and climate on the evolution of soil-mantled hillslopes. *Geomorphology* 263, 99-112.

Bowden, M.C.B., Ford, S., Gaffney, V.L. & Tingle, M. 1991. Skimming the surface or scraping the barrel: a few observations on the nature of surface and sub-surface archaeology. In: J. Schofield (ed.). *Interpreting artefact scatters: contributions to ploughzone archaeology*. Oxford: Oxbow Books. Oxbow Monographs 4, 107-113.

Bowen, D.Q. 1994. Late Cenozoic Wales and South-west England. *Proceedings of the Ussher Society* 8, 209-213.

Bradley, B. & Sampson, C.G. 1978.Artifacts from the Cottages site. In: Sampson, C.G. 9ed.). *Paleoecology and archaeology of an Acheulean site at Caddington, England*. Dallas: Southern Methodist University, 83-137.

Bradley, J.M. 1995. *An evaluation of the impact of PPG16 on archaeology and planning*. Unpublished M.Phil thesis, University College London.

Bradley, R. 2002. *The past in prehistoric societies.* London: Routledge.

Brenan, J. 1994. PPG16 and the restructuring of archaeological practice in Britain. *Planning practice and research* 9(4), 395-405.

Breuil, H. 1926. Palaeolithic industries from the beginning of the Rissian to the beginning of the Wurmian glaciation. *Man* 26, 176-179.

Breuil, H. 1930. Le Clactonien et sa place dans la chronologie. *Bulletin de la Société Préhistorique de France* 27(4), 221-227.

Breuil, H. 1951. *Boucher de Perthes. Ses précurseurs, ses continuateurs.* Abbeville: F. Paillart.

Breuil, H. & Kelley, H. 1954. Le Paléolithique Ancien. *Bulletin de la Société Préhistorique de France* 51(8), 9-26.

Briant, R.M., Kilfeather, A.A., Parfitt, S., Penkman, K.E.H., Preece, R.C., Roe, H.M., Schwenninger, J-L., Wenban-Smith, F.F. & Whittaker, J.E. 2012. Integrated chronological control on an archaeologically significant Pleistocene river terrace sequence: the Thames-Medway, eastern England. *Proceedings of the Geologists' Association* 123(1), 87-108.

Bridgland, D.R.1985.Uniclinal shifting: a speculative reappraisal based on terrace distribution in the London Basin. *Quaternary Newsletter* 47, 26-33.

Bridgland, D.R. 1994. *Quaternary of the Thames*. London; New York: Chapman & Hall. Geological Conservation Review Series 7.

Bridgland, D.R. 1996. Quaternary river terrace deposits as a framework for the Lower Palaeolithic record. In: C.S. Gamble & A.S. Lawson (eds.), *The English Palaeolithic reviewed. Papers from a day conference held at the Society of Antiquaries of London, 28 October 1994.* Salisbury:Trust for Wessex Archaeology, 23-39.

Bridgland, D.R. 2000. River terrace systems in north-west Europe: an archive of environmental change, uplift and early human occupation. *Quaternary Science Reviews* 19, 1293-1303.

Bridgland D.R. 2001. The Pleistocene evolution and Palaeolithic occupation of the Solent River. In:F.F. Wenban-Smith & R.T. Hosfield (eds.). *Palaeolithic archaeology of the Solent River*. London: Lithic Studies Society. Lithic Studies Society Occasional Paper 7, 15-25.

Bridgland, D.R. 2003. The evolution of the River Medway, SE England, in the context of Quaternary palaeoclimate and the Palaeolithic occupation of NW Europe. *Proceedings of the Geologists' Association* 114, 23-48.

Bridgland, D.R. 2006. The Middle and Upper Pleistocene sequence in the Lower Thames: a record of Milankovitch climatic fluctuation and early human occupation of southern Britain. Hentry Stopes memorial lecture 2004. *Proceedings of the Geologists' Association* 117, 281-305.

Bridgland, D.R. 2010.The record from British Quaternary river systems within the context of global fluvial archives. *Journal of Quaternary Science* 25(4), 433-446.

Bridgland, D.R. & D'Olier, B. 1995.The Pleistocene evolution of the Thames and Rhine drainage systems in the southern North Sea Basin. In: R.C. Preece (ed.). *Island Britain: a Quaternary perspective*. London: The Geological Society, 27-45. Geological Society Special Publication 96.

Bridgland, D.R., Keen, D.H., Schreve, D.C. & White, M.J. 1998. Quaternary drainage of the Kentish Stour. In: J.B. Murton, C.A. Whiteman, M.R. Bates, D.R.Bridgland, A.J. Long, M.B. Roberts & M.P. Waller (eds.).1998. *The Quaternary of Kent and Sussex*. *Field Guide*. London: Quaternary Research Association, 39-54.

Bridgland, D.R., Maddy, D. & Bates, M. 2004. River terrace sequences: templates for Quaternary geochronology and marine-terrestrial correlation. *Journal of Quaternary Science* 19(2), 203-218.

Bridgland, D.R., Preece, R.C., Roe,H.M., Tipping, R.M., Coope, G.R., Field, M.H., Robinson, J.E., Schreve, D.C. & Crowe, K. 2001. Middle Pleistocene interglacial deposits at Barling, Essex, England: evidence for a longer chronology for the Thames terrace sequence. *Journal of Quaternary Science* 16(8), 813-840.

Bridgland D.R. & Schreve, D.C. 2001. River terrace formation in synchrony with long-term climatic fluctuation: supporting mammalian evidence from southern Britain. In: D. Maddy, M.G. Macklin & J.C. Woodward (eds.). *River basin sediment systems: archives of environmental change.* Lisse; Abingdon: A.A. Balkema, 229-248.

Bridgland, D.R. & Westaway, R. 2008. Climatically controlled river terrace staircases: a worldwide Quaternary phenomenon. *Geomorphology* 98, 285-315.

Bridgland, D.R. & Westaway, R. 2014. Quaternary fluvial archives and landscape evolution: a global synthesis. *Proceedings of the Geologists' Association* 125, 600-629.

Brocard, G.Y., van de Beek, P.A., Bourlès, D.L., Siame, L.L. & Mugnier, J-L. 2003. Long-term fluvial incision rates and postglacial river relaxation time in the French Western Alps from ^{10}Be dating of alluvial terraces with assessment of inheritance, soil development and wind ablation effects. *Earth and Planetary Science Letters* 209, 197-214.

Brown, A.G., Basell, L.S., Robinson, S. & Burdge, G.C.2013.Site distribution at the edge of the Palaeolithic world: a nutritional niche approach. *PLos ONE* 8(12): e81476. doi:10.1371/journal.pone.0081476, 1-14. Retrieved on 22 July 2019 from World Wide Web.

Buck, L.T. & Stringer, C.B. 2014. Having the stomach for it: a contribution to Neanderthal diets? *Quaternary Science Reviews*96, 161-167.

Buckland, P. 2005. Paleoecological evidence for the Vera hypothesis? In: K.H. Hodder, J.M. Bullock, P.C. Buckland & K.J. Kirby. *Large herbivores in the wildwood and modern grazing systems.* Peterborough: English Nature, 62-116. English Nature Research Report 648.

Bull, A.J. 1940. Cold conditions and landforms in the South Downs. *Proceedings of the Geologists' Association* 51(1),63 -71.

Burkhardt, R.W. Jnr. 2013. Lamarck, Jean Baptiste. *Brenners Encyclopaedia of Genetics* (2nd. edition). Volume 4. Amsterdam; London: Elsevier, 184-186. Retrieved on 28 December 2018 from World Wide Web Doi.10.10.1016/B978-0-12-374984-0.00844-5.

Burrin, P.J. & Scaife, R.G. 1984. Aspects of Holocene valley sedimentation and floodplain development in southern England. *Proceedings of the Geologists' Association* 95(1), 81-96.

Busby, J.P., Lee, J.R., Lender, S., Williamson, P. & Norris, S. 2016. Regional modelling of permafrost thicknesses over the past 130 ka: implications for permafrost development in Great Britain. *Boreas* 45, 46-80.

Cameron, D.G., Bide, T., Parry, S.F., Parker, A.S. & Mankelow, J.M. 2014. *Directory of Mines and Quarries* 10th ed. Keyworth, Nottingham: British Geological Survey.

Campbell, J.B. & Hubbard, R.N.L.B. 1978. Biological investigations of the Rackley site. In: C.G. Sampson (ed.). *Palaeoecology and archaeology of an Acheulean site at Caddington, England.* Dallas: Southern Methodist University, 47-60.

Campbell, J.B. & Sampson, C.G.1978. The Cottages site. In: C.G. Sampson (ed.). *Palaeoecology and archaeology of an Acheulean site at Caddington, England.* Dallas: Southern Methodist University,61-81

Carozzi, A.V. 1964. Lamarck's theory of Earth: Hydrogéologie. *Isis* 55(3), 293-307.

Caruth, J. 2018. 'Engaging with policy' – a successful day conference. *Rescue news* 126, 2.

Catt, J.A. 1977. Loess and coversands. In: F.W.Shotton (ed.). *British Quaternary studies: recent advances*. Oxford: Clarendon Press, 221-229.

Catt, J.A. 1978. Sediments from the Rackley site. In: C.G. Sampson (ed.). *Palaeoecology and archaeology of an Acheulean site at Caddington, England.* Dallas: Southern Methodist University,39- 46.

Catt, J.A. 1979. Soils and Quaternary geology in Britain. *Journal of Soil Science* 30, 607-642.

Catt, J.A. 1986. The nature, origin and geomorphological significance of Clay-with-flints. In: G. de G. Sieveking & M.B. Hart (eds.). *The scientific study of flint and chert. Proceedings of the fourth international flint*

symposium held at Brighton Polytechninc 1-15 April 1983. Cambridge: Cambridge University Press,151-159.

Catt, J.A. 1996. Recent work on Quaternary palaeosols in Britain. *Quaternary International* 34-36, 183-190.

Catt, J.A. 2000. Aspects of silcretes and comparison with some Australian occurrences: comment. *Proceedings of the Geologists' Association* 111, 86-90.

Catt, J. 2010. Neogene deposits and early landscape development. In: J. Catt (ed.). *Hertfordshire geology and landscape.* Welwyn Garden City: Hertfordshire Natural History Society, 79-117.

Catt, J.A., Edmonds, C., Bailey, H. & Green, C. 2010. Mineral resources and church building stones. In: J. Catt (ed.). *Hertfordshire geology and landscape.* Welwyn Garden City: Hertfordshire Natural History Society, 299-321.

Catt, J.A., Gibbard, P.L., Lowe, J.J., McCarroll, D., Scourse, J.D. Walker, M.J.C. & Wymer, J. 2006. Quaternary ice sheets and their legacy. In: P.J. Brenchley & P.F. Rawson, (eds.). *The geology of England and Wales*. (2nd edition). Bath: Geological Society of London, 429-467.

Catt, J.A. & Hodgson, J.M. 1976. Soils and geomorphology of the Chalk in south-east England. *Earth Surface Processes* 1, 181-193.

Catt, J.A., Hubbard, R.N.L.B. & Sampson, C.G. 1978. Summary and conclusions. In: C.G. Sampson (ed.). *Palaeoecology and archaeology of an Acheulean site at Caddington, England.* Dallas: Southern Methodist University, 139 -149.

Catteddu, I., Baillieu, M.A., Depaepe, P. & Roffignon, A. 2012. L'archéologie preventive en France: un service public original. *Post Classical Archaeologies* 2, 319-336.

Central Bedfordshire Council 2017. Planning application number CB/17/01598/Full. (https://centralbedfordshire.gov.uk/planning). https://centralbedfordshire.gov.uk/planning Retrieved on 25 January 2018 from World Wide Web:

Chandler, R.H. 1916. The implements and cores of Crayford. *Proceedings of the Prehistoric Society of East Anglia* 2(2), 240-248

Chandler, R.H. & Leach, A.S.1907. Excursion to Crayford and Dartford Heath. *Proceedings of the Geologists' Association* 20, 122-126.

Chandler, R.H. & Leach, A.S. 1911. Excursion to Dartford Heath. *Proceedings of the Geologists' Association* 22, 171-175.

Chauhan, P.R., Bridgland, D.R., Moncel, M-H., Antoine, P., Bahain, J-P., Briant, R., Cunha, P.P., Despriée, J., Limondin-Lozouet, N., Locht, J-L., Martins, A.A., Schreve, D.C., Shaw, A.D., Voinchet, P., Westaway, R., White, M.J. & White, T.S. 2017. Fluvial deposits as an archive of early human activity: progress during the 20 years of the Fluvial Archives Group. *Quaternary Science Reviews* 166, 114-149.

Christiansen, R. 1981. *A regional history of the railways of Great Britain volume 13. Thames and Severn*. Newton Abbot: David & Charles.

Churchill, S.E. 2006. Bioenergetic perspectives on Neanderthal thermoregulatory and activity budgets. In: K. Harvati & T. Harrison (eds.). *Neanderthals revisited: new approaches and perspectives*. Dordrecht: Springer, 113-133.

Churchill, S.E., Walker, C.S. & Schwartz, A.M. 2016. Home-range size in large-bodied carnivores as a model for predicting Neandertal territory size. *Evolutionary Anthropology* 25(3), 117-123.

Clarke, M.R. & Green, C.P. 1987. The Pleistocene terraces of the Bournemouth-Fordingbridge area. In: K.E. Barber (ed.). *Wessex and the Isle of Wight Field Guide*. Cambridge: Quaternary Research Association, 58-64.

Clarke, M., Milodowski, A.E., Bouch, J.E., Leng, M.J. & Northmore, K.J. 2007. New OSL dating of UK loess: indications of two phases of Late Glacial dust accretion in SE England and climate implications. *Journal of Quaternary Science* 22(4), 361-371.

Cohen, K.M., MacDonald, K., Joordens, J.C.A., Roebroeks, W. and Gibbard, P.L. 2012. The earliest occupation of Europe: a coastal perspective. *Quaternary International* 271,70-83.

Coleman, A. 1952. Some aspects of the development of the Lower Stour, Kent. *Proceedings of the Geologists' Association* 63, 63-86.

Collcutt, S. 2001. The *sackung* hypothesis: a challenge for Palaeolithic prospection. In: S. Milliken & J. Cook (eds.). *A very remote period indeed. Papers on the Palaeolithic presented to Derek Roe*. Oxford: Oxbow Books, 222-233.

Commont, V. 1910a. Note préliminaire sur les terrasses fluviatiles de la vallée de la Somme: epoque de l'apparition de l'homme quaternaire. *Annales de la Société Géologique du Nord* 39, 185-210.

Commont, V. 1910b. L'industrie des lames dans les stations paléolithiques d'Amiens. *Revue des études anciennes* 12(2), 170-176.

Commont, V. 1911. Découverte d'un gisement de silex taillés à Hermies (P.-de-C.). *Annales de la Société Géologique du Nord* 11, 289-291.

Commont, V. 1916a. Les terrains quaternaires des tranchées du nouveau Canal du Nord. *L'Anthropologie* XXVII, 309-350.

Commont, V. 1916b. Les hommes contemporains du Renne dans la vallée de la Somme. *Bulletin de la Société Préhistorique de France* 13(2), 107-111.

Commont, V. 1916c. Les gisements paléolithiques du ravin d'Hermies à Marcoing. *L'Anthropologie* XXVII, 517-538.

Cook, W.H. & Killick, J.R. 1924. On the discovery of a flint-working site of Palaeolithic date in the Medway valley at Rochester, Kent, with notes on

the driftstages of the Medway. *Proceedings of the Prehistoric Society of East Anglia* 4(2), 133-154.

Council for British Archaeology. Retrieved on 25 January 2018 from World Wide Web: www.new.archaeologyuk.org/cuts-to-archaeology-services.

Cranshaw, S. 1983. *Handaxes and cleavers. Selected English Acheulean industries*. Oxford: British Archaeological Reports, British Series 113.

Crawshay, de B. 1892. Notes on the western Chalk plateau. *Journal of the Anthropological Institute of Great Britain and Ireland* 21, 267.

Crawshay, de B. 1924. Eoliths found “in situ” at South Ash, Kent. *Proceedings of the Prehistoric Society of East Anglia* 4(2), 155-162.

Creveling, J.R., Mitrovica, J.X., Hay, C.C. & Austermann, J. 2015. Revisitng tectonic corrections applied to Pleistocene sea-level highstands. *Quaternary Science Reviews* 111, 72-80.

Curwen, E.C. 1954. *The archaeology of Sussex*. London: Metheun. 2nd revised edition.

Dale, W. 1912. On the implement-bearing gravels of the lower valley of the Test. *Proceedings of the Society of Antiquaries* 2nd series XXIV, 108-116.

Dale, W. 1913. Further note on the implement-bearing gravels of the valley of the Test. *Proceedings of the Society of Antiquaries* 2nd series XXV, 46-51.

Dale, W. 1918. Report of local secretary for Hampshire. *Proceedings of the Society of Antiquaries* 2nd series XXX, 20-32.

Davies, W. The Abbé Henri Breuil (1877-1961). In: R.T. Hosfield, F.F. Wenban-Smith & M.I. Pope (eds.). *Great prehistorians: 150 years of Palaeolithic research, 1859-2009. Lithics* 30,127-141.

Davis, R.J., 2013. *Palaeolithic archaeology of the Solent River: human settlement history and technology.* Unpublished Ph.D. thesis, University of Reading.

Davis, R.J. 2014. Concerning the earliest occupation of Britain: the geological context of a handaxe assemblage from Foxholes, Bournemouth, Southern England. *Lithics* 35, 33-39.

Davis, R.J., Hatch, M., Ashton, N., Hosfield, R. & Lewis, S.G. 2016. The Palaeolithic record of Warsash, Hampshire, U.K: implications for late Lower and early Middle Palaeolithic occupation history of Southern Britain. *Proceedings of the Geologists’ Association* 127(5), 558-574. http://dx.doi.org/10.1016/j.pgeola.2016.09.005

Dawkins, W.B. 1880. *Early man in Britain and his place in the Tertiary period*. London: Macmillan.

Demoule, J-P. 2016. Preventive archaeology: scientific research or commercial activity? In: P. Novaković, M. Horňák, M.P. Guermandi, H. Stäuble, P. Depaepe & J-P Demoule (eds.). *Recent developments in*

preventive archaeology in Europe. Proceedings of the 22nd EEA meeting in Vilnius 2016. Ljubljana: Ljubljana University of Press, Faculty of Arts, 9-20.

Dennell, R.W., Martinon-Tórres, M. & Bermudez de Castro, J. M. 2011. Hominin variability,climatic instability and population demography in Middle Pleistocene Europe. *Quaterary Science Reviews* 30, 1511-1524.

Depaepe, P. 2010. L'apport des fouilles grand superficie sur la connaissance du Paléolithique Moyen. In: N.J. Conard & A. Delagnes (eds.). Settlement dynamics of the Middle Palaeolithic and Middle Stone age Volume 3. Tubingen: Kerns Verlag, 357-372.

Depaepe, P. 2016. Preventive archaeology, scientific research and public outreach. In: P. Novaković, M. Horňák, M.P. Guermandi, H. Stäuble, P. Depaepe & J-P Demoule (eds.). *Recent developments in preventive archaeology in Europe. Proceedings of the 22nd EEA meeting in Vilnius 2016*. Ljubljana: Ljubljana University of Press, Faculty of Arts, 33-40.

Depaerpe, P. & Salas-Rossenbach, K. 2013. Preventive archaeology in France: review and point of view. In: M.P.Guermandi & K. Salas-Rossenbach (eds.)> *Twenty years after Malta. Preventive archaeology in Europe and Italy.* Bologna:IBC, 129-136.

Department for Digital Culture, Media and Sport 2013. *Scheduled monuments and nationally important but non-scheduled monuments*. Retrieved on 17 May 2018 from World Wide Web www.gov.uk/dcms

De Warrimont, J.P.L.M.N.de 2007. Prospecting Middle Palaeolithic open-air sites in the Dutch-Belgian border area near Maastricht. *PalArch's Journal of Northwest Europe* 1(3), 41-89.

Dewey, H. 1925. The Palaeolithic gravels of Sturry. *Proceedings of the Geologists' Association* 36, 278-284.

Dewey, H.D. 1944. Llewellyn Treacher. *Proceedings of the Geologists' Association* 55(1), 42-44.

Dewey, H. & Smith, R.A. 1914. The Palaeolithic sequence at Swanscombe, Kent. *Proceedings of the Geologists' Association* 25(2), 90-97.

Dewey, H. & Smith, R.A. 1925. Flints from the Sturry gravels, Kent. *Archaeologia* 74, 117-136.

Dines, H.G. 1929. The flint industries of Bapchild. *Proceedings of the Prehistoric Society of East Anglia* 6 (1), 12-26.

Douglas, I.1976. Erosion rates and climate: geomorphological implications. In: E. Derbyshire (ed.). *Geomorphology and climate*. Chichester: John Wiley, 269-287.

Drinkall, H.C. 2013. *Expanding our horizons: an exploration of hominin landscape use in the Lower Palaeolithic of Britain and the question of upland home bases or lowland living sites.* Unpublished Ph.D. thesis, University of Durham.

Duchadeau-Kervazo, C. 1986. Les sites paléolithiques du basin de la Dronne (nord de l'Aquitaine. Observations sur les modes et emplacements. *Bulletin de la Société Préhistorique Française* 83(2), 56-64.

Dunbar, R.I.M. 1993. Coevolution of neocortical size, group size and language in humans. *Behavioural and Brain Sciences* 16(4), 681-735.

Dunbar, R.I.M. 1998. The social brain hypothesis. *Evolutionary Anthropology* 6, 178-190.

Dunbar, R.I.M. and Schultz, S. 2007. Evolution in the social brain. *Science* 317, 1344-1347.

Dyer, J. 1978. Worthington George Smith. In: *Worthington George Smith and other studies presented to Joyce Godber.* Bedford: Bedfordshire Historical Record Society. Bedfordshire Historical Record Society Publications 57, 141-179.

Edmonds, C.N. 1983. Towards the prediction of subsidence risk upon the Chalk outcrop. *Quarterly Journal of Engineering Geology*. 16, 261-266.

Evans, J. 1860. On the occurrence of flint implements in undisturbed beds of gravel, sand and clay. *Archaeologia* 38, 280-307.

Evans, J. 1861. On the occurrence of flint implements in undisturbed beds of gravel, sand and clay. *Archaeologia* 38(2), 280-307.

Evans, J. 1863. Account of some further discoveries of flint implements in the drift on the Continent and in England. *Archaeologia* 39(1), 57-85.

Féblot-Augustins, J. 1993. Mobility strategies in the Late Middle Palaeolithic of central Europe and western Europe: elements of stability and variability. *Journal of Anthropological Archaeology* 12, 211-265.

Field, D., Nicolayson, P. & Cotton, J. 1999. The Palaeolithic sites at Limpsfield, Surrey: an analysis of the artefacts collected by A.M. Bell. *Surrey Archaeological Collections* 86, 1-32.

Flatman, J. and Perring, D. 2012. The National Planning Policy Framework and Archaeology: a discussion. *PIA* 22, 4-10.

FLOOD 1 Project
https://www.bgs.ac.uk/research/groundwater/flooding/Flood1.html
Retrieved on 19 August 2019 from World Wide Web

Foley, R.A. 2016. Mosaic evolution and the pattern of transitions in the hominin lineage. *Philosophical Transactions of the Royal Society B* 371:20150244. Retrieved on 19 July 2017 from World Wide Web. https://dx.doi.org/10.1098/rstb.2015.0244.

Ford, S. 1986. Fieldwalking survey of North Stoke. Unpublished fieldwalking archive SOX1850, Oxfordshire County Council Historic Environment Register.

Ford, S. 1987. Flint scatters and prehistoric settlement patterns in south Oxfordshire and east Berkshire. In: A.G. Brown & M.R. Edmonds (eds.). *Lithic analysis and later British prehistory. Some problems and approaches.*

Oxford: BAR British Series 162. Reading Studies in Archaeology 2, 101-135.

Ford, S. & Hazell, A. 1989. Prehistoric, Roman and Anglo-Saxon settlement patterns at North Stoke, Oxfordshire. *Oxoniensia* LIV, 7-23.

Foulds, F.W.F. 2012. *Imperceptible individuals. Issues in the application of social theory to Lower Palaeolithic material culture. Volume 1.* Unpublished PhD thesis, University of Durham.

Foulds, F.W.F. 2016. Exploring late Neanderthal locales: preliminary reanalyses of Middle Palaeolithic assemblages from the Axe Valley. *Lithics* 37, 79-82.

French, H.M. 1972. Asymmetrical slope development in the Chiltern hills. *Biuletyn Peryglacjalny* 21, 51-73.

Frere, J. 1800. Account of flint weapons discovered at Hoxne in Suffolk. By John Frere, Esq. F.R.S. and F.A.S. In a letter to the Rev. John Brand, Secretary. *Archaeologia* 13, 204-205.

Funnell, B.M. 1995. Global sea level and the (pen)insularity of late Cenezoic Britain. In: R.C. Preece (ed.). *Island Britain: a Quaternary perspective*. London: The Geological Society. Geological Society Special Publication 96, 3-13.

Gallup, C.D., Edwards, R.L. & Johnson, R.G. 1994. The timing of high sea-levels over the past 200 years. *Science* 63, 796-800.

Gamble, C. 1986. *The Palaeolithic settlement of Europe.* Cambridge: Cambridge University Press.

Gamble, C. 1987. Man the shoveller. Alternative models for Middle Pleistocene colonization and occupation in northern latitudes. In: O. Soffer (ed.), *The Pleistocene Old World: regional perspectives*. New York: Plenum Press, 81-98.

Gamble, C. 1993. *Timewalkers*: *the prehistory of global colonisation.* Cambridge Massachusetts: Harvard University Press.

Gamble, C. 1995a. Lithics and social evolution. In: A.J. Schofield (ed.), *Lithics in Context. Suggestions for the Future Direction of Lithic Studies*. London: Lithic Studies Society. Lithic Studies Society Occasional Paper 5, 19-26.

Gamble, C. 1995b. The earliest occupation of Europe: the environmental background. In: W. Roebroeks & T. van Kolfcholen (eds.). *The earliest occupation of Europe. Proceedings of the European Science Foundation Workshop at Tauteval (France), 1993.* Leiden: University of Leiden, 279-295.

Gamble, C. 1996a. Making tracks: hominid networks and the evolution of the social landscape. In: J. Steele & S. Shennan (eds.). *The archaeology of human ancestry: power, sex and tradition*. London; New York: Routledge, 253-277.

Gamble, C. 1996b. Hominid behaviour in the Middle Pleistocene: an English perspective. In: C.S. Gamble & A.S. Lawson (eds.), *The English Palaeolithic reviewed. Papers from a day conference held at the Society of Antiquaries of London, 28 October 1994.* Salisbury:Trust for Wessex Archaeology, 63-71.

Gamble, C. 1998. Palaeolithic society and the release from proximity: a network approach to intimate relations. *World Archaeology* 29(3), 426-449.

Gamble, C. 1999. *The Palaeolithic societies of Europe*. Cambridge: Cambridge University Press.

Gamble, C. S. 2002. Early beginnings 500-35,000 years ago. In: P.Slack & R. Ward (eds.). *The peopling of Britain: the shaping of a human landscape. The Linacre lectures 1999*. Oxford: Oxford University Press, 11-37.

Gamble, C. 2009a. Human display and dispersal: a case study from biotidal Britain in the Middle and Upper Pleistocene. *Evolutionary Anthropology* 18, 144-156.

Gamble, C. 2009b. 150 years of cutting edge research. In: R.T. Hosfield, F.F. Wenban-Smith & M.I. Pope (eds.). *Great prehistorians: 150 years of Palaeolithic research, 1859-2009. Lithics* 30, 9-12.

Gamble, C. 2013. *Settling the earth. The archaeology of deep human history*. Cambridge: Cambridge University Press.

Gamble, C. 2018. Thresholds in hominin complexity during the Middle Pleistocene. A persistent places approach. In: M. Pope, J. McNabb & C. Gamble (eds.). *Crossing the human threshold. Dynamic transformation and persistent places during the Middle Pleistocene*. London; New York: Routledge, 3-23.

Gamble, C., Gowlett, J. & Dunbar, R. 2011. The social brain and the shape of the Palaeolithic. *Cambridge Archaeological Journal* 21(1), 115-135.

Gamble, C., Gowlett, J. & Dunbar, R. 2014. *Thinking big: how the evolution of social life shaped the human mind*. London: Thames and Hudson.

Gamble, C. & Kruszynski, R. 2009. John Evans, Joseph Prestwich and the stone that shattered the time barrier. *Antiquity* 83, 461-475.

Gamble, C. & Moutsiou, T. 2011. The time revolution of 1859 and the stratification of the primeval mind. *Notes and Records of the Royal Society of London* 65 (1), 43-63.

Gamble, C. & Roebroeks, W. 1999. The Middle Palaeolithic: a point of inflection. In: W. Roebroeks & C.Gamble (eds.). *The Middle Palaeolithic occupation of Europe*. Leiden: University of Leiden, 3-21.

García-Moreno, D., Gupta, S., Collier, J.S., Oggioni, F., Vanneste, K., Trentesaux, A., Verbeeck, A.K, Vaersteeg, W., Jomard, H., Camelbeeck, T. & De Batist, M. 2019. Middle-Late Pleistocene landscape evolution of the Dover Strait inferred from buried and submerged erosional landforms. *Quaternary Science Reviews* 203, 209-232.

Gargani, J., Stab, O., Cojan, I. & Brulhet, J. 2006. Modelling the long-term fluvial erosion of the river Somme during the last million years. *Terra Nova* 18, 118-129.

Garraway Rice, R. 1905. On some Palaeolithic implements from the terrace gravels of the River Arun and the Western Rother. *Proceedings of the Society of Antiquaries* 20, 197-207.

Garraway-Rice, R. 1911. Report of Local Secretary for Sussex: the Palaeolithic period. *Proceedings of the Society of Antiquaries* 32, 79-82.

Gautney, J.R. & Holliday, T. 2015. New estimations of habitable land area and human population size at the Last Glacial Maximum. *Journal of Archaeological Science* 58, 103-112.

Gibbard, P.L. 1977. Pleistocene history of the Vale of St Albans. *Philosophical Transactions of the Royal Society of London Series B* 280, 445-482.

Gibbard, P.L. 1979. Middle Pleistocene drainage in the Thames Valley. *Geological Magazine* 116(1), 35-44.

Gibbard, P.L. 1985.The *Pleistocene history of the Middle Thames Valley*. Cambridge: Cambridge University Press.

Gibbard, P.L. 1986. Flint gravels in the Quaternary of southeast England. In: G. de G. Sieveking & M.B. Hart (eds.). *The scientific study of flint and chert. Proceedings of the fourth international flint symposium held at Brighton Polytechnic 1-15 April 1983*. Cambridge: Cambridge University Press,141-149.

Gibbard, P.L. 1995a. The formation of the Strait of Dover. In: R.C. Preece (ed.). *Island Britain: a Quaternary perspective*. London: The Geological Society,15 -26. Geological Society Special Publication 96.

Gibbard, P.L. 1995b. Palaeogeographical evolution of the Lower Thames Valley. In: D.R. Bridgland, P. Allen & B.A. Haggert (eds.). *The Quaternary of the lower reaches of the Thames. Field Guide.* London: Quaternary Research Association, 5-34.

Gibbard, P.L. 1999. The Thames valley, its tributary valleys and their former courses. In: D.Q.Bowen (ed.). *A revised correlation of Quaternary deposits in the British Isles.* Bath: Geological Society.Geological Society Special Report 23, 45-58.

Gibbard, P.L. 2007. Palaeogeography. Europe cut drift. *Nature* 448, 259-260.

Gibbard, P.L. & Allen, L.G. 1994. Drainage evolution in south and east England during the Pleistocene. *Terra Nova* 6, 444-452.

Gibbard, P.L. & Cohen, K.M. 2015.Quaternary evolution of the North Sea and the English Channel. *Proceedings of the Open University Geological Society* 1, 63-74.

Gibbard, P.L. & Lautridou, J.P. 2003. The Quaternary history of the English Channel: an introduction. *Journal of Quaternary Science* 18(3-4), 195-199.

Gibbard, P.L. & Lewin, J. 2002.Climate and related controls on interglacial fluvial sedimentation in lowland Britain. *Sedimentary Geology* 151, 187-210.

Gibbard, P.L. & Lewin, J. 2003. The history of the major rivers of southern Britain during the Tertiary. *Journal of the Geological Society, London* 160, 829-845.

Gibbard, P.L. & Lewin, J. 2009. River incision and terrace formation in the late Cenozoic of Europe. *Techtonophysics* 474, 41-55.

Gibbard, P.L. and Lewin, J. 2016. Partitioning the Quaternary. *Quaternary Science Reviews* 151, 127-139.

Gilligan, I. 2017. Clothing and hypothermia as limitations for midlatitude hominin settlement during the Pleistocene. A comment on Hosfield 2016. *Current Anthropology* 58(4), 534-535.

Glauberman, P. 2006. Excavating surface sites, tapping a source of potential: the Middle Palaeolithic surface scatters of southern Limburg (NL) and the case study of Colmont-Ponderosa. *Nederlandse Archeologische Rapporten* 31, 87-106.

Glauberman, P. 2016. Middle Palaeolithic land-use in Dutch and Belgian Limburg: integrating data from surface sites. *Quaternary International* 411, 198-215.

Gossling, F. 1940. A contribution to the Pleistocene history of the Upper Darent Valley. *Proceedings of the Geologists' Association* 51(4), 291-405.

Goudie, A.S. 1990. *The landforms of England and Wales.* Oxford: Blackwell.

Goudie, A.S. 2016. Quantification of rock control in geomorphology. *Earth-Science Reviews* 159, 374-387.

Goval, E. & Coutard, S. 2016. Préhistoire ancien et traces lineaires: les apports du Canal Seine-Nord Europe. *Archéopages* 43, 92-100.

Gowlett, J.A.J. 2009. Boucher de Perthes: pioneer of Palaeolithic prehistory. In: R.T. Hosfield, F.F. Wenban-Smith & M.I. Pope (eds.). *Great prehistorians: 150 years of Palaeolithic research, 1859-2009. Lithics* 30, 13-24.

Gregory, K.J. 1976. Drainage networks and climate. In: E. Derbyshire (ed.). *Geomorphology and climate*. London: Wiley.

Grinsell, L. 1929. The Lower and Middle Palaeolithic periods in Sussex. *Sussex Archaeological Collections* 70, 172-182.

Groenendijk, A.J. & de Warrimont, J.P. 1995. Middlepaleolithische opervlatke vindplaatsen in de Voerstreek. *Archeologie in Limburg* 65, 33-45.

Groenendijk, A.J. & de Warrimont, J.P. 2007. Prospecting Middle Palaeolithic open-air sites in the Dutch-Belgian border area near Maastricht. *PalArch's Journal of Archaeology of Northwest Europe* 1(3), 41-89.

Grove, M. 2010. The archaeology of group size. In: R. Dunbar, C. Gamble & J. Gowlett (eds.). *Social Brain, distributed mind.* Oxford: published for the British Academy by Oxford University Press, 391-411.

Grove, M. 2011. Change and variability in Plio-Pleistocene climates: modelling the hominin response. *Journal of Archaeological Science* 38, 3038-3047.

Grove, M. 2014. Evolution and dispersal under climatic instability: a simple evolutionary algorithm. *Adaptive Behaviour* 22(4), 235-254.

Grove, M. & Dunbar, R. 2015. Local objects, distant symbols: fission-fusion social systems and the evolution of human cognition. In: F. Coward, R. Hosfield, M. Pope & F. Wenban-Smith (eds.). *Settlement, society and human cognition in human evolution. Landscapes in mind*. Cambridge: Cambridge University Press,15-30.

Grove, M., Pearce, E. & Dunbar, R.I.M. 2012. Fission-fusion and the evolution of hominin social systems. *Journal of Human Evolution* 62, 191-200.

Guérin, G., Antoine, P., Schmidt, E., Goval, E., Hérisson, D., Jamet, G., Reyss, J-L., Quingfeng S., Philippe, A., Vibet, M-A.& Bahain, J-J. 2017. Chronology of the Upper Pleistocene loess sequence of Havrincourt (France) and associated Palaeolithic occupations: a Bayesian approach from pedostratigraphy, OSL, radiocarbon, TL and ESR/U series data. *Quaternary Geochronology* 42, 15-30.

Gupta, S., Collier, J.S., Palmer-Felgate, A. & Potter, G. Catastrophic flooding origin of shelf valley systems in the English Channel. *Nature* 448, 342-346.

Guthrie, R.D. 1990. *Frozen fauna of the mammoth steppe: the story of Blue Babe.* Chicago: Chicago University Press.

Haase, D., Fink, J., Haase, G., Ruske, R., Pésci, M., Richter, H., Altermann, M. & Jäger, K.-D. 2007. Loess in Europe- its spatial distribution based on a European loess map, scale 1:2,500,000. *Quaternary Science Reviews* 26, 1301-1312.

Halliwell, G. & Parfitt, K. 1993. Non-river gravel Lower and Middle Palaeolithic discoveries in Kent. *Kent Archaeological Review* 114, 80-89.

Hancock, G.S. & Anderson, R.S. 2002. Numerical modelling of fluvial-strath terrace formation in response to oscillating climate. *Geological Society of America Bulletin*114(9), 1131-1142.

Hardaker, T.2004. Present-day Lower Palaeolithic landsurfaces in Britain: two examples from the Upper Thames. *Lithics* 25, 22-38.

Hardaker, T. 2007. *The Lower and Middle Palaeolithic of Oxfordshire*. Solent Thames Archaeological Research Framework. Oxford: Oxford Archaeology. Retrieved on 15 October 2015 from World Wide Web https://oxfordarchaeology.com/images/pdfs/Solent_Thames/County_resource_assessments/Lower_Middle_Palaeo_Oxon.pdf

Hardaker, T. 2012. The artefacts from the present land surface at the Palaeolithic site of Warren Hill, Suffolk, England. *Proceedings of the Geologists' Association* 123, 692-713.

Hardaker, T. 2017. Lower Palaeolithic artefacts in surface contexts in Britain with special reference to the Northern Drift (Oxfordshire) and Warren Hill (Suffolk). *Proceedings of the Geologists' Association* 128(3), 303-325.

Hardy, K., Buckley, S., Collins, M.J., Estalrrich, A., Brothwell, D., Copeland, L., García-Tabernero, A., García-Vargas, S., de la Rasilla, M., Lalueza-Fox, C., Huguet, R., Bastir, M., Santamaria, D., Madella, M., Wilson, J., Cortéz, Á.F.& Rosas, A. 2012. Neanderthal medics? Evidence for food, cooking and medicinal plants entrapped in dental calculus.*Naturwissenschaften* 99, 617-626.

Hardy, B.L. & Moncel, M-H. 2011. Neanderthal use of fish, mammals, birds, starchy plants and wood 125-250,000 years ago. PLosONE 6(8). Retrieved 22 February 2020 from World Wide Web.
e23768. doi:10.1371/journal.pone.0023768.

Harp, P. 2005. Work at the Lower Palaeolithic site at Rookery Farm, Lower Kingswood, 2001-5. *Surrey Archaeological Collections* 92, 231-244.

Harris, C. R.E., Ashton, N. & Lewis, S.G. 2019. From site to museum: a critical assessment of collection history on the formation and interpretation of the British Early Palaeolithic record. *Journal of Palaeolithic Archaeology* 2(1), 1-25.

Harrison, E.R. 1928. *Harrison of Ightham: a book about Benjamin Harrison of Ightham, Kent made up principally of extracts from his notebooks and correspondence*. London: Oxford University Press.

Haselgrove, C. 1985. Inference from ploughsoil artefact samples. In: C. Haselgrove, M.Millett, & I. Smith (eds.). *Archaeology from the ploughsoil*: *studies in the collection and interpretation of field survey data.* Sheffield: Sheffield University Department of Archaeology and Prehistory, 7-29.

Hatch, M., Davis, R.J., Lewis, S.G., Ashton, N., Briant, R.M. & Lukas, S. 2016. The stratigraphy and chronology of the fluvial sediments at Warsash, UK: implications for the Palaeolithic archaeology of the River Test. *Proceedings of the Geologists' Association* 128(2), 198-221. http://dx.doi.org/10.1016/j.pgeola.2016.12.001

Henry, A.G., Brooks, A.S. & Piperno, D.R. 2011. Microfossils in calculus demonstrate consumption of plants and cooked foods in Neanderthal diets (Shanidar III, Iraq; Spy I and II, Belgium). *Proceedings of the National Academy of Sciences of the USA* 108(2), 486-491.

Henry, A.G., Brooks, A.S. & Piperno, D.R. 2014. Plant foods and the dietary ecology of Neanderthals and early modern humans. *Journal of Human Evolution* 69, 44-54.

Hérisson, D., Brenet, M., Cliquet, D., Moncel, M-H., Richter, J., Scott, B., Van Baelen, A., Di Modica, K., De Loecker, D., Ashton, N., Bourgignon, L., Delagnes, A., Faivre, J-P., Folgaado-Lopez, M., Locht, J-L., Pope. M., Raynal, J-P., Roebroeks, W., Sangata, C., Turq, A. & Van Peer, P. 2016a. The emergence of the Middle Palaeolithic in north-western Europe and its southern fringes. *Quaternary International* 411, 233-283.

Hérisson, D., Coutard, S., Goval, E., Locht, J-L., Antoine, P., Chantreau, Y. and Debenham, N. 2016b. A new key-site for the end of Lower Palaeolithic and the onset of Middle Palaeolithic at Etricourt-Manancourt (Somme, France). *Quaternary International* 409, 73-91.

Hérisson, D. & Goval, E. 2013. Du Paléolithique inférieur au debut du Paléolithic supérieur dans le Nord de la France: lumière sur les premières découvertes du Canal Seine-Nord Europe. *Notae Praehistoricae* 33, 91-104.

Hind, J. & Hey, G. 2014. Introduction to an archaeological research framework for the Solent-Thames sub-region: resource assessment and research agenda. In: G. Hey & J. Hind (eds.) 2014. *The Solent Thames Research Framework for the Historic Environment. Resource Assessments and Research Agendas Project Report.* Oxford: Oxford Wessex Monograph 6, 1-16. Retrieved on 12 April 2019 from World Wide Web. https://library.thehumanjourney.net/2597/.

Higginbottom, I.E. & Fookes, P.G. 1970.Engineering aspects of periglacial features in Britain. *Quarterly Journal of Engineering Geology* 3, 85-117.

Hijma, M.P., Cohen, K.M., Roebroeks,W., Westerhoff, W.E. & Busschers, F.S. 2012. Pleistocene Rhine-Thames landscapes: geological background for hominin occupation of the southern North Sea region. *Journal of Quaternary Science* 27(1), 17-39.

Hirzel, A.H. & Le Lay, G. 2008. Habitat suitability modelling and niche theory. *Journal of Applied Ecology* 45(5), 1372-1381.

Historic England 2016. *Building the future, transforming our past. Celebrating development-led archaeology in England 1990-2015.* Retrieved on 22 January 2018 from World Wide Web: https://historicengland.org.uk/advice/planning/planning-system/

Historic England 2018. *Sites of early human activity: scheduling selection guide*. Retrieved on 18 June 2019 from World Wide Web: https://historicengland.org.uk/listing/selection-criteria/scheduling-selection/

Hoare, P. & Ashton, N.M. 2016. The Dallow Farm handaxe: Worthington George Smith's association with a very early archaeological find. *Lithics* 37, 68-72

Hoare, P. & White, M. 2017. Worthington George Smith: a man of exquisite talents. *British Archaeology* 2017(4), 50-55.

Hodgson, M.A., Catt, J.A. & Weir, A.H. 1967. The origin and development of Clay-with-flints and associated soil horizons on the South Downs. *Journal of Soil Science* 18, 85-102.

Hook, B., Brown, D., Lloyd-James, O., Thomas, R. and Williams, J. 2016. *National infrastructure development and historic environment skills and capacity 2015-33: an assessment.* Retrieved on 19 January 2018 from World Wide Web. www.historicengland.org.uk/images-books/publications/national-infrastructure-development-and-capacity-2015-33-assessment/

Horton, A., Worssam, B.C. & Whittow, J.B. 1981. The Wallingford fan gravel. *Philosophical Transactions of the Royal Society of London* Series B 293(1064), 215-255.

Hosfield, R.T. 1998. *A regional model of hominid behaviour during the middle Pleistocene.* Unpublished Ph.D. thesis. University of Southampton.

Hosfield, R.T. 1999. *The Palaeolithic of the Hampshire Basin: a regional model of hominid behaviour during the Middle Pleistocene*. Oxford: Archaeopress. British Archaeology Reports British Series 286.

Hosfield, R.T. 2001. The Lower Palaeolithic of the Solent: 'site' formation and interpretive frameworks. In: F.F. Wenban-Smith and R.T. Hosfield (eds.). *Palaeolithic archaeology of the Solent River. Proceedings of the Lithic Studies Society day meeting held at the Department of Archaeology, University of Southampton on Saturday 15th January 2000,* 85-97.

Hosfield, R.T. 2005. Individuals among palimpsest data: fluvial landscapes in southern England. In: C. Gamble & M. Porr (eds.). *The hominid individual in context. Archaeological investigations of Lower and Middle Palaeolithic landscapes, locales and artefacts.* Abingdon, Oxon: Routledge, 220-243.

Hosfield, R.T. 2009. The unsung heroes. In: R.T. Hosfield, F.F. Wenban-Smith & M.I. Pope (eds.). *Great prehistorians: 150 years of Palaeolithic research, 1859-2009. Lithics* 30, 185-200.

Hosfield, R.T. 2016. Walking in a winter wonderland? Strategies for Early and Middle Pleistocene survival in midlatitude Europe. *Current Anthropology* 57(5), 653-682.

Hosfield, R.T. & Chambers, J.C. 2005. Pleistocene geochronologies for fluvial sedimentary sequences: an archaeologist's perspective.*Journal of Quaternary Science* 20(3), 285-296.

Hosfield, R.T. & Cole, J. 2019. Earliest Europeans: integrating perspectives from archaeology, palaeoanthropology and palaeoclimatology. *Quaternary Science Reviews* 208, 140-142.

Hoskins, R. 1998. Lower Palaeolithic discoveries at Eyethorne, near Dover. With discussion by Geoff Halliwell and Keith Parfitt, Dover Archaeological Group. *Kent Archaeological Review* 134, 73-80.

HS2 2017. *High Speed Two. Phase One information paper E8: archaeology* Retrieved on 20 January 2018 from World Wide Web: www.gov.uk/government/uploads/system/uploads/attachment-

data/file/672380/E8-_Archaeology_v.1.5. Search terms HS2 archaeology.

https://www.gov.uk/government/news/hs2-begins-archaeology-work-exploring-over-10000-years-of-british-history Retrieved on 19 June 2019 from World Wide Web. Search terms HS2 archaeology.

https://.www.jncc.defra.gov.uk/page-1436 Retrieved on 5 January 2018 from World Wide Web. Search terms UK uplands.

http://www.populstat.info/ Retrieved on 18 October 2018 from World Wide Web

https://www.nationaltrust.org.uk/ashridge-estate . Retrieved on 28 October 2018 from World Wide Web. Search terms Ashridge Estate.

Hublin, J-J. & Roebroeks, W. 2009. Ebb and flow or regional extinctions? On the character of Neanderthal occupation of northern environments. *Comptes Rendus Palevol* 8, 503-509.

Huijzer, A.S. & Vandenbergh, J.E.F. 1998. Climatic reconstruction of the Weichselian pleniglacial in northwestern and central Europe. *Journal of Quaternary Science* 13(5), 391-417.

Hulin, G., Bayard, D., Depaepe, P., Koehler, A. & Prilaux, G. 2018. Geophysics and preventive archaeology: comparison with trial trenching on the CSNE project (France). *Archaeological Prospection,* 1-12, Retrieved on 20 June 2018 from World Wide Web. https://doi-org.libproxy.ucl.ac.uk/10.1002/arp.1598

Hunn, J.R. 1994. *Reconstruction and measurement of landscape change. A study of six parishes in the St. Albans area.* Oxford: Tempus Reparatum Archaeological and Historical Associates Ltd. British Archaeological Reports British Series 236.

Hunn, J.R. 2007. *H.G. Matthews Brickworks, Bellingdon, Buckinghamshire. Project design for Geoarchaeological Recording on behalf of H.G. Matthews Ltd*. Archaeological Services and Consultancy Ltd.

Hunn, J.R. 2011. *Geoarchaeological Recording: Bellingdon Buckinghamshire: Phase 3.* Archaeological Services and Consultancy Ltd. unpublished report series. Retrieved on 5 May 2015 from World Wide Web. https://archaeologydataservice.ac.uk/archsearch/record?titleId=2595189

Hurel, A. & Coye, N. 2011. Introduction. In: A. Hurel & N.Coye (eds.). *Dans l'epaisseur du temps. Archéologues et géologues inventent la préhistoire*. Paris: Muséum National d'Histoire Naturelle, 7-37.

Hutson, J.M. 2016. Comment. *Current Anthropology* 57(5) 671-672.

Isaac, G. 1989. Stone Age visiting cards: approaches to the study of early land use patterns. In: B. Isaac (ed.). *The archaeology of human origins. Papers by Glyn Isaac*. Cambridge: Cambridge University Press, 206-227.

Jamieson, W.A. 1914. The Clay with Flints. *Proceedings of the Prehistoric Society of East Anglia* 1(4), 458-460.

Johnson, M. 2010. *Archaeological theory: an introduction*. (2nd edition). Chichester: Wiley-Blackwell.

Jones, D.K.C. 1980. The Tertiary evolution of south-east England with particular reference to the Weald. In: D.K.C. Jones (ed.). *The shaping of southern England.* London: Academic Press, 13-47. Institute of British Geographers Special Publication 11.

Jones, D.K.C. 1981. *Southeast and southern England.* London: Methuen.

Jones, D.K.C. 1999a. Evolving models of the Tertiary evolutionary geomorphology of southern England, with special reference to the Chalklands. In: B.J.Smith, W.B. Whalley & P.A. Warke (eds.). *Uplift, erosion and stability. Perspectives on long-term landscape development*. London: Geological Society of London, 1-23.Geological Society of London Special Publications 162.

Jones, D.K.C. 1999b. On the uplift and denudation of the Weald. B.J.Smith, W.B. Whalley & P.A. Warke (eds.). *Uplift, erosion and stability. Perspectives on long-term landscape development*. London: Geological Society of London, 25-43. Geological Society of London Special Publications 162.

Jones, R.L. & Keen, D.H. 1993. *Pleistocene environments in the British Isles*. London:Chapman Hall.

Kaufmann, G. 2014. Geophysical mapping of solution and collapse sinkholes. *Journal of Applied Geophysics* 111, 271-288.

Keily, J.2017. *Tunnel: the archaeology of Crossrail*. London: Crossrail Ltd.

Kennard, A.S. 1944. The Crayford brickearths. *Proceedings of the Geologists' Association* 55(3), 121-143.

Kennard, A.S. 1947. Fifty and one years of the Geologists' Association. *Proceedings of the Geologists' Association* 58(4), 271-293.

Kent County Council (2018) *Stour Basin Palaeolithic Project* [data-set]. York: Archaeology Data Service [distributor]. Retrieved on 14 January 2018 from World Wide Web. https://doi.org/10.5284/1046264

Kerney, M.P., Brown, E.G. & Chandler, T.J. 1964. The Late-glacial and Post-glacial history of the Chalk escarpment near Brook, Kent. *Philosophical Transactions of the Royal Society of London Series B. Biological Sciences 248, 135-204.*

Kerney, M.P., Levy, J.F. & Oakley, K.P. 1963. Late glacial deposits on the Chalk of South-east England. *Philosophical Transactions of the Royal Society of London Series B. Biological Sciences* 246 (730), 203-254.

Kiden, P. & Törnquist, T.E. 1998. Can river terrace flights be used to quantify Quaternary tectonic uplift rates? *Journal of Quaternary Science* 13(6), 573-5.

Kirkaldy, J.F. and Bull, A.J.1940. The geomorphology of the rivers of the southern Weald. *Proceedings of the Geologists' Association* 51(2) 8-150.

Kolen, J., De Loecker, D., Groenendijk, A.J. and de Warrimont, J.P. 1999. Middle Palaeolithic surface scatters: how informative? A case study from southern Limburg (the Netherlands. In: W. Roebroeks and C. Gamble (eds.). *The Middle Palaeolithic occupation of Europe.* Leiden: University of Leiden,177-191.

Lagarde, J.L., Amorese, D., Laville, E. & Dugué, O. 2003. The structural evolution of the English Channel area. *Journal of Quaternary Science* 18(3-4), 201-213.

Laignel, B., Quesnel, F., Meyer, R. & Lebret, P.1998. Les bièfs à silex: dépôts périglaciaires de versant issus des altérites à silex de plateau du basin de Paris. *Bulletin de la Société Géologique de France* 169(4), 605-612.

Lake, R.D., Wood, C.J. & Mortimore, R.N. 1987. *Geology of the country around Lewes.* London: HMSO. Memoirs of the British Geological Survey (Sheet 319).

Lambeck, K., Esat, T.M.& Potter, E-K., 2002a. Links between climate and sea levels for the past three million years. *Nature* 419, 199-206.

Lambeck, K., Yokoyama, Y. & Purcell, T. 2002b, Into and out of the Last Glacial Maximum: sea-level change during Oxygen isotope stages 3 and 2. *Quaternary Science Reviews* 21*,* 343-360*.*

Lamdin-Wymark, H.2009. Sir John Evans: experimental flintknapping and the origins of lithic research. In: R.T. Hosfield, F.F. Wenban-Smith & M.I. Pope (eds.). *Great prehistorians: 150 years of Palaeolithic research, 1859-2009. Lithics* 30, 45-52.

Lankester, R. 1912. On the discovery of a novel type of flint implements below the base of the Red Crag of Suffolk. Proving the existence of skilled workers of flint in the Pliocene age. *Philosophical Transactions of the Royal Society B series* 202, 283-336.

Lawrence, U.2005. *The engineering geology of the Clay-with-flints (as shown on the British Geological Survey 1:50,000 New series geological sheets*. Unpublished Ph.D. thesis. University of Surrey School of Engineering.

Lea, D.W., Martin, P.A., Pak, D.K. & Sperbo, H.J. 2002. Reconstructing a 350-kyr history of sea-level using planktonic Mg/Ca and oxygen isotope records from a Cocos Ridge core. *Quaternary Science Reviews* 21, 283-293.

Leopold, L.B & Bull, W.B. 1979. Base level, aggradation and grade. *Proceedings of the American Philosophical Society* 123(3), 168-202.

Lewin, J. & Gibbard, P.L. 2010. Quaternary river terraces in England: forms, sediments and processes. *Geomorphology* 120(3-4), 293-311.

Lewis, S.G., Ashton, N. & Jacobi, R. 2011. Testing human presence during the Last Interglacial (MIS5e): a review of the British evidence. In: N. Ashton, S.G. Lewis & C. Stringer (eds.). *The ancient human occupation of*

Britain. Amsterdam; London: Elsevier,125-164. Developments in Quaternary Science 14.

Llobera, M. 2003. Extending GIS-based visual analysis: the concept of visualscapes. *International Journal of Geographical Information Science* 17(1), 25-48.

Locht, J-L., Sellier, N., Coutard, S., Antoine, P. & Feray, P. 2010. La detection du sites Paléolithique ancien et moyen dans le nord de France: une approche particulière. In: P. Depaepe and F.Séara (eds.). *Le diagnostic des sites paléolithiques et mésolithiques.* Cahiers de l'INRAP 3, 50-57.

Long, A.J., Barlow, N.L.M., Busschers, F.S., Cohen, K.M., Gehrels, W.R. & Wake, L.M. 2015. Near-field sea-level variability in northwest Europe and ice sheet stability during the last interglacial. *Quaternary Science Reviews* 126, 26-40.

Loveday, J. 1962. Plateau deposits of the southern Chiltern hills. *Proceedings of the Geologists' Association* 73, 83-102.

Lowe, J.J. and Walker, M.J.C. 1997. *Reconstructing Quaternary environments*. (2nd edition). Harlow: Prentice Hall

MacDonald, K. 2016. Comment. *Current Anthropology* 57(5), 672-3.

McBurney, C.M.B. 1950. The geographical study of the older Palaeolithic stages in Europe. *Proceedings of the Prehistoric Society* 16, 163-183.

McDowell, P.W., Coulton, J., Edmonds, C.N. & Poulson, A.J. 2008. The nature, formation and engineering significance of sinkholes related to dissolution of chalk in SE Hampshire. *Quarterly Journal of Engineering Geology* 41(3), 279-290.

McMillan, A.A. & Powell, J.H. 1999. *BGS rock classification scheme Volume 4. Classification of artificial (man-made) ground and superficial deposits – applications to geological maps and datasets in the UK*. Keyworth: British Geological Survey. British Geological Survey Research Report RR 99-04.

McNabb, J. 2006.The lying stones of Sussex. An investigation into the role of the flint tools in the development of the Piltdown forgery. *Archaeological Journal* 163(1), 1-41.

McNabb, J. 2009. The knight, the grocer and the chocolate brownies: Joseph Prestwich, Benjamin Harrison and the second 'Antiquity of Man' debate. In: R.T. Hosfield, F.F. Wenban-Smith & M.I. Pope (eds.). Great prehistorians: 150 years of Palaeolithic research, 1859-2009. *Lithics* 30, 97-115.

McNabb, J. 2012. *Dissent with modification. Human origins, Palaeolithic archaeology and evolutionary anthropology in Britain 1859-1901.* Oxford: Archaeopress.

McNabb, J. 2015. Seeding the stony ground. Further insights from the stone tools found at Piltdown. In: N. Ashton & C. Harris (eds.). *No stone*

unturned. Papers in honour of Roger Jacobi. London: Lithic Studies Society, 1-18. Lithic Studies Society Occasional Paper 9.

Maddy, D. 1997. Uplift driven valley incision and river terrace formation in southern England. *Journal of Quaternary Science* 12(6), 539-545.

Maddy, D. 1998. Reply: can river terrace flights be used to quantify Quaternary tectonic uplift rates? *Journal of Quaternary Science* 13(6), 574-575.

Martins, Á.A., Cunha, P.P., Rosina, P., Osterbeek, L., Cura, S., Grimaldi, S, Gomes, J., Buylaert, J-P., Murray, A.S. & Matos, J. 2010. Geoarchaeology of Pleistocene open-air sites in the Vila Nov de Barquina-Santa Cita area (Lower Tejo river basin, central Portugal. *Proceedings of the Geologists' Association* 121, 128-140.

Meijer, T. & Preece, R.C. 1995. Malacological evidence relating to the insularity of the British Isles during the Quaternary. In: R.C. Preece (ed.). *Island Britain: a Quaternary perspective.* London: The Geological Society, 89-110. Geological Society Special Publication 96.

Milks, A., Champion, S. Cowper, E., Pope, M. & Carr, D. 2016. Early spears as thrusting weapons: isolating force and impact velocities in human performance trials. *Journal of Archaeological Science: Reports* 10, 191-203.

Ministry of Housing and Local Government 2019. Revised National Planning Policy Framework. Accessed on 3 April 2019 from World Wide Web. https://www.gov.uk/government/collections/revised-national-planning-policy-framework.

Moffat, A.J. & Catt, J.A. 1986. A re-examination of the evidence for a Plio-Pleistocene marine transgression on the Chiltern Hills. II. Drainage patterns. *Earth Surface Processes and Landforms* 11(2), 169-180.

Moir, J.R. 1911. The flint implements of sub-Crag man. *Proceedings of the Prehistoric Society of East Anglia* 1(1),17-24.

Moir, J.R. 1927. *The antiquity of man in East Anglia*. Cambridge: Cambridge University Press.

Moir, J.R. 1934. The pre-Crag men of East Anglia. *Nature* 1(3402), 64-65.

Morgan, R.P.C.1971. A morphometric study of some valley systems on the English Chalklands. *Transactions of the Institute of British Geographers* 54, 33-44.

Mortimore, R.N. 1997. *The Chalk of Sussex and Kent.* London: Geologists' Association. Geologists' Association Guide 57.

Mortimore, R.N. 2001a. The Upper Cretaceous rocks of the British Isles. In: R.N. Mortimore, C.J.Wood & R.W. Gallois. *British Upper Cretaceous stratigraphy*. Peterbrough: Joint Nature Conservation Committee, 1-26. Geological Conservation Review Series 53.

Mortimore, R.N. 2001b. *Report on mapping of the Chalk Channel coast of France from Port du Havre-Antifer to Ault June-September 2001*. Report for

Bureau de Recherches Géologiques et Minières (BRGM), BP 6009 – 45060 Orléans cedex 2.

Mortimore, R.N. 2011. A Chalk revolution: what have we done to the Chalk. *Proceedings of the Geologists' Association* 122, 232-297.

Mortimore, R.N. & Pomerol, B. 1987. Correlation of the Upper Cretaceous White Chalk (Turonian to Campanian) in the Anglo-Paris Basin. *Proceedings of the Geologists' Association*, 98, 97-143.

Mortimore, R.N. & Wood, C.J. 1986. The distribution of flint in the English Chalk, with particular reference to the 'Brandon Flint Series' and the high Turonian flint maximum. In: G. de G. Sieveking & M.B. Hart (eds.). *The scientific study of flint and chert. Proceedings of the fourth international flint symposium held at Brighton Polytechnic 1-15 April 1983*. Cambridge: Cambridge University Press, 7-20.

Murton, J.B. & Belshaw, R.K. 2011. A conceptual model of valley incision, planation and terrace formation during cold and arid permafrost conditions of Pleistocene southern England. *Quaternary Research* 75, 385-394.

Murton, J.B. & Giles, D.P. 2016. *The Quaternary periglaciation of Kent. Field Guide*. Quaternary Research Association.

Murton, J.B. & Lautridou, J-P. 2003. Recent advances in the understanding of Quaternary periglacial features of the English Channel coastlands. *Journal of Quaternary Science* 18(3-4), 301-307.

Nicholls, R.J. 1987. Evolution of the upper reaches of the Solent river and the formation of Poole and Christchurch bays. In: K.E. Barber (ed.). *Wessex and the Isle of Wight Field Guide*. Cambridge: Quaternary Research Association,99-115.

Novaković, P. 2016. Preface. In: P. Novaković, M. Horňák, M.P. Guermandi, H. Stäuble, P. Depaepe & J-P. Demoule (eds.). *Recent developments in preventive archaeology in Europe. Proceedings of the 22nd EEA meeting in Vilnius 2016*. Ljubljana: Ljubljana University Faculty of Arts, 5-8.

Oakley, K. 1957. Tools makyth man. *Antiquity* XXXI, 199-209.

Oakley, K.P.1963. (5th reprinted edition). *Man the tool-maker.* London: British Museum (Natural History).

Oakley, K.P. 1964. *Frameworks for dating fossil man.* London: Weidenfeld and Nicolson.

Oakley, K.P. & Leakey, M. 1937. Report on excavations at Jaywick Sands, Essex (1934), with some observations on the Clactonian industry, and on the fauna and geological significance of the Clacton Channel. *Proceedings of the Prehistoric Society* 3, 217-260.

Obermaier, H. 1919-1920. Das Paläolithikum und Epipaläolithikum Spaniens. *Anthropos* 14-15(1-3), 143-179.

O'Connor, A. 2003. Geology, archaeology and 'the raging vortex of the "eolith" controversy'. *Proceedings of the Geologists' Association* 114, 255-262.

O'Connor, A. 2007. *Finding time for the Old Stone Age. A history of Palaeolithic archaeology and Quaternary geology in Britain*. Oxford: Oxford University Press.

Oxford Archaeology North. 2015. *National importance programme: lithic sites assessment 7046 Final report.* Retrieved on 17 May 2018 from World Wide Web. https://www.historicengland.org.uk/images-books/publications/lithic-sites-assessment/.

Parfitt, K. & Halliwell, G. 1996. More Palaeolithic discoveries in East Kent. *Kent Archaeological Review* 123, 58-64.

Parfitt, K. & Halliwell, G. 2002. Dover: thirty years in search of Palaeolithic man. *Current Archaeology* 179, 483-485.

Paterson, T.T. 1940. Geology and early man: II. *Nature* 146(3689), 49-52.

Paterson, T.T. & Fagg, B.E.B. 1940. Studies on the Palaeolitic succession in England No. II. The Upper Brecklandian Acheul (Elveden). *Proceedings of the Prehistoric Society* 6,1-29.

Pengelly, W. 1873. Ninth report od the committee for exploring Kent's Cavern, Devonshire. *Report of the forty-third meeting of the British Association for the Advancement of Science held at Bradford September 1873*, 178-209.

Pettitt, P. 2009. Francois Bordes. In: R.T. Hosfield, F.F. Wenban-Smith & M.I. Pope (eds.). Great prehistorians:150 years of Palaeolithic research, 1859-2009. *Lithics* 30, 201-212.

Pettitt, P., Gamble C. & Last, J. (eds.). 2008. *Research and conservation framework for the British Palaeolithic*. London: English Heritage.

Pettitt, P.B. & White, M.J. 2011. Cave men: stone tools, Victorian science and the 'primitive mind' of deep time. *Notes and records of the Royal Society of London* 65(1), 25-42.

Pettitt, P. & White, M. 2012a. Return to Kent's Cavern. New excavations in Britain's oldest Scheduled Ancient Monument. *Current Archaeology* 262, 14-19.

Pettitt, P. & White, M. 2012b. *The British Palaeolithic: human societies at the edge of the Pleistocene world*. London; New York: Routledge.

Pitt, M. & Roberts, M. 1997. *Fairweather Eden. Life in Britain half a million years ago as revealed by the excavations at Boxgrove*.London: Century .

Pitt Rivers Museum. *Englishness Bell collection.* Retrieved on 27 September 2018 from World Wide Web. http://england.prm.ox.ac.uk/englishness-Bell-collection

Pope, M.I. 2002. *The significance of biface rich assemblages: an examination of behavioural controls on lithic assemblage formation in the Lower Palaeolithic.* Unpublished Ph.D. thesis, University of Southampton.

Pope, M. 2004. Behavioural implications of biface discard: assemblage variability and land-use at the Middle Pleistocene site of Boxgrove. In: E.A. Walker, F.F. Wenban-Smith, and F. Healy. *Lithics in action: papers from*

the conference Lithic Studies in the year 2000. Oxford: Oxbow Books, 38-47. Lithic Studies Society Occasional Paper 8.

Pope, M. 2008. Early Upper Palaeolithic archaeology at Beedings, West Sussex: new concepts for Pleistocene archaeology. *Archaeology International* 11, 33-36.

Pope, M. 2018. Thresholds in behaviour, thresholds of visibility. Landscape processes, asymmetries in landscape records and niche construction in the formation of the Palaeolithic record. In: M. Pope, J. McNabb & C. Gamble (eds.). *Crossing the human threshold. Dynamic transformation and persistent places during the Middle Pleistocene.* London; New York: Routledge, 24-39.

Pope, M., Blundell, L., Cutler, H. and Scott, B. 2015a. At the headwaters of the English Channel River: considering late Neanderthal archaeology in the Sussex Weald. In: N. Ashton and C. Harris (eds.). *No stone unturned: papers in honour of Roger Jacobi*. London: Lithic Studies Society, 31-42. Lithic Studies Society Occasional Paper 9.

Pope, M., Blundell, L., Scott, B. and Cutler, H., 2016. Behaviour and process in the formation of the North European Acheulean record: towards a unified Palaeolithic landscape approach. *Quaternary International* 411, 85-94.

Pope, M., Dinnis, R., Milks, A., Toms, P. & Wells, C. A. 2013. Middle Palaeolithic to Early Upper Palaeolithic succession from an open air site at Beedings, West Sussex. *Quaternary International* 316, 14-26. http://dx.doi.org/10.1016/j.quaint.2013.06.027

Pope, M. & Roberts, M.2005.Observations on the relationship between Palaeolithic individuals and artefact scatters at the Middle Pleistocene site of Boxgrove. In: C. Gamble & Porr, M. (eds.).*The hominid individual in context. Archaeological investigations of Lower and Middle Palaeolithic landscapes, locales and artefacts*. Abingdon,Oxfordshire:Routledge, 81-97.

Pope, M., Scott, B., Mills, J., Bates, M., Bates, R., Blinkhorn, E., Conneller, C., Duffy, S., Julien, M-A, Ravon, M-L. & Shaw, A. 2015b. Discoveries from La Manche: five years of early prehistoric research in the Channel Island of Jersey. *Archaeology International18, 113-123.*

Porter, S.C. 1989. Some geological implications of average Quaternary glacial conditions. *Quaternary Research* 32, 245-261.

Potts, A.S. Browne, T.J. & Rendell, H.M. 1983. Hydrology and water supply in Sussex. In:Geography Editorial Committee, University of Sussex (eds.).*Sussex: environment, landscape and society.* Gloucester: Alan Sutton, 67-87.

Preece,R.C., Scourse, J.D., Houghton, S.D., Knudsen, K.L. & Penney, D.N.1990. The Pleistocene sea-level and neotectonic history of the eastern Solent, Southern England. *Philosophical Transactions of the Royal Philosophical Society* B328, 425-477.

Prestwich, J. 1860a. On the occurrence of flint-implements associated with the remains of animals of extinct species in beds of a late geological period in France at Amiens and Abbeville and in England at Hoxne. *Philosophical Transactions of the Royal Society of London* 150, 277-317.

Prestwich J. 1860b. On the occurrence of flint-implements, associated with the remains of extinct mammalia, in undisturbed beds of a late geological period. *Proceedings of the Royal Society* 10, 50-59.

Prestwich, J. 1889. On the occurrence of Palaeolithic flint implements in the neighbourhood of Ightham, Kent, their distribution and probable age. *Quarterly Journal of the Geological Society* 45, 270-297.

Prestwich, J. 1891. On the age, formation and successive drift-stages of the Darent Valley; with remarks on the Palaeolithic implements of the district, and on the origin of its Chalk escarpment. *Quarterly Journal of the Geological Society* 47, 126-160.

Prestwich, J. 1892. On the primitive characters of flint implements of the Chalk plateau of Kent, with reference to the question of their glacial or pre-glacial age. *Journal of the Anthropological Institute of Great Britain and Ireland* 21, 246-262.

Prilaux, G. & Talon, M. 2012. Le programme archéologique du Canal Seine-Nord Europe: une opportunité hors norms pour l'étude de la Préhistoire dans le nord de la France. *Notae Praehistoricae* 32, 99-114.

Quesnel, F., Catt, JJ., Laignel, B., Bourdillon, C. & Meyer, R. 2003. The Neogene and Quaternary Clay-with-flints north and south of the English Channel: comparisons of distribution, age, genetic processes and geodynamics. *Journal of Quaternary Science* 18(3-4), 283-294.

Raynal, J-P., Moncel, H., Fernandes, P., Bindon, P., Daujeard, C., Fiore, I., Santagata,C., Lecorre-le Beux, M., Guadelli, J-L., Le Pape, J-M., Tagliacozzo, A., Liabeuf, R., Servant, L., Aulanier, M. & Seret, H. 2013. Land-use strategies, related tool kits and social organisation of Lower and Middle Palaeolithic groups in the south-east of the Massif Central, France. *Quartar* 60, 29-59.

Reid, C. 1897. On the origin of dry chalk valleys and of Coombe Rock. *Quaterly Journal of the Geologists Association 43(1-4), 364-373.*

RESCUE 2012. The National Planning Policy Framework and Archaeology: a response by RESCUE – The British Archaeological Trust. *PIA* 22, 11-12.

Rigollot, M-J. 1856. Mémoire sur des instruments en silex trouvé a Saint-Acheul, prés de Amiens. *Memoires de la Société des Antiquaires de Picardie* 4, 23-60.

Roberts, A. 2013. Palaeolithic British Isles. In: D. Hicks & A. Stevenson (eds.). *World archaeology at the Pitt Rivers Museum: a characterization.* Oxford: Archeopress,169-215.

Roberts, M.B., Gamble, C.S. & Bridgland, D.R. 1995. The earliest occupation of Europe: the British Isles. In: W. Roebroeks & T. van Kolfcholen (eds.). *The earliest occupation of Europe. Proceedings of the*

European Science Foundation Workshop at Tauteval (France), 1993. Leiden: University of Leiden, 165-191.

Robinson, D.A. & Williams, R.B.G. 1983. The Sussex coast past and present. In: The Geography Editorial Committee, University of Sussex (eds.). *Sussex: environment, landscape and society.* Gloucester: Alan Sutton, 50-66.

Rocks-Macqueen, D. 2018. *Have we reached peak archaeologists? (in the United Kingdom).* Sheffield: Landward Research Ltd. Landward Research White Papers 001.

Roe, D.A. 1968. *A gazetteer of British Lower and Middle Palaeolithic Sites*. London: Council for British Archaeology.

Roe, D.A. 1969. British Lower and Middle Palaeolithic handaxe groups. *Proceedings of the Prehistoric Society* 34, 1-82.

Roe, D.A. 1978. Foreword. In: C.G. Sampson (ed.). *Palaeoecology and archaeology of an Acheulean site at Caddington, England.* Dallas: Southern Methodist University, ix-x.

Roe, D.A. 1981. *The Lower and Middle Palaeolithic periods in Britain*. London: Routledge and Kegan Paul.

Roe, D.A. 1996. Artefact distribution and the British Lower Palaeolithic. In: C.S. Gamble & A.S. Lawson (eds.), *The English Palaeolithic reviewed. Papers from a day conference held at the Society of Antiquaries of London, 28 October 1994.* Salisbury:Trust for Wessex Archaeology, 1-6.

Roe, D.A. 2009. Worthington George Smith (1835-1917). In: R.T. Hosfield, F.F. Wenban-Smith & M.I. Pope (eds.). Great prehistorians: 150 years of Palaeolithic research, 1859-2009*. Lithics* 30, 85-95*.*

Roebroeks, W. 2006, The human colonisation of Europe: where are we? *Journal of Quaternary Science* 21(5), 425-435.

Roebroeks, W., Conard, N.J. & van Kolfschoten, T. 1992a. Dense forests, cold steppes, and the Palaeolitic settlement of northern Europe. *Current Anthropology* 33(5), 351-586.

Roebroeks, W., Kolen, J. & De Loecker, D. 1987. An early Weichselian site at Maastricht-Belvédère (Site J). *Praehistorica Leidensia* 20,1-9.

Roebroeks, W., Kolen, J. & Rensink, E. 1988. Planning depth, anticipation and the organisation of Middle Palaeolithic technology: the “Archaic natives” meet Eve’s descendants. *Helinium* 28(1), 17-34.

Roebroeks, W., De Loecker, D., Hennekens, P. & van Ieperen, M. 1992b A ‘veil of stones’: on the interpretation of early Middle Palaeolithic low density scatter at Maastricht-Belvédère (The Netherlands). *Analecta Praehistorica Leidensia* 25,1-16.

Roebroeks, W., Hublin, J-J. & MacDonald, K. 2011.Continuities and discontinuities in Neanderthal presence: a closer look at northwestern Europe. In: N..Ashton, S.G. Lewis & C. Stringer (eds.). *The ancient human*

occupation of Britain. Amsterdam; London: Elsevier, 113-123. Developments in Quaternary Science 14.

Ronan, C.A. 2008. Halley, Edmond. *Complete Dictionary of Scientific Biography volume 6.* Detroit, Michigan: Charles Scribner's Sons, 67-72.

Rose, J. 1994. Major river systems of central and southern Britain during the Early and Middle Pleistocene. *Terra Nova* 6, 435-444.

Rose, J. 2006. A perspective on D.R. Bridgland's paper 'The Middle and Upper Pleistocene sequence in the Lower Thames: a record of Milankovitch climatic fluctuation and early human occupation of southern Britain'. *Proceedings of the Geologists' Association* 117, 277-279.

Sackett, J. 2014. François Bordes and the Old Stone Age. *Bulletin of the History of Archaeology* 24(3), 1-9.

Salomon, A. 1911. Découverte d'un gisement de silex taillés à Hermies (P-de-C). *Annales de la Société Géologique du Nord* 11, 289-291.

Salomon, A. 1912a. Découverte de nouveaux ateliers Paléolithiques, au lieu dit "Bertincourt" à Hermies. *Bulletin de la Société Préhistorique de France* 9(11), 672-676.

Salomon, A. 1912b. Récolte de quelques outils faisant présumer l'existence d'un atelier acheuléen sur le territoire de Ruyaulcourt (Pas-de-Calais). *Bulletin de la Société Préhistorique de France* 9(9), 553-556.

Salomon, A. 1912c. Decouverture d'une station moustérienne, d'instruments néolithiques et d'une hache à douille, près d'Hermies (P-de-C). *Bulletin de la Société Préhistorique de France* 9(3), 183-190.

Salomon, A. 1913. Découverte d'un troisième gisement moustérien, sur le territoire d'Hermies (P-de-C) au lieu dit la Vallée de Bertincourt. *Bulletin de la Société Préhistorique de France* 10(3), 191-196.

Sampson, C.G. 1978. Introduction. In: C.G. Sampson (ed.). *Palaeoecology and archaeology of an Acheulean site at Caddington, England.* Dallas: Southern Methodist University, 3-15.

Sandom, C.J., Ejrnæs, R., Hansen, M.D.D. & Svenning, J-C. 2014. High herbivore density associated with vegetation diversity in interglacial ecosystems. *Proceedings of the National Academy of Sciences of the United States of America* 111(11), 4162-4167.

Scaife, R.G. & Burrin, P.J. 1983. Floodplain development in and the vegetational history of the Sussex High Weald and some archaeological implications. *Sussex Archaeological Collections* 121, 1-10.

Schlanger, S.H. 1992. Recognizing persistent places in Anasazi settlement patterns. In: J. Rossignol & L. Wandsnider (eds.) *Space, time and archaeological landscapes*. New York: Springer, 91-112.

Schoch, W.H., Bigga, G., Böhner, U., Richter, P. & Terberger, T. 2015.New insights on the wooden weapons from the Palaeolithic site of Schoningen.

Journal of Human Evolution 2015. Retrieved on 14 October 2015 from World Wide Web. http://dx.doi.org/10.1016/j.jhevol.2015.08.004. Retrieved

Schofield, J. 1994. Looking back with regret; looking forward with optimism. In: A. David & N. Ashton (eds.). *Stories in stone*. London: Lithic Studies Society, 90-98. Lithic Studies Society Occasional Paper 4.

Schreve, D.C. 2001. Differentiation of the British late Middle Pleistocene interglacials: the evidence from mammalian biostratigraphy. *Quaternary Science Reviews* 20 (16-17), 1693-1705.

Schreve, D. 2016. Terrestrial fluvial landscapes. In: M.J. White (ed.) 2016. *Lost landscapes of Palaeolithic Britain: the contribution of projects funded by the Aggregates Levy Sustainability Fund 2002-2011*. Oxford: Oxford Archaeology,73-101. Oxford Archaeology Monograph 26.

Schumm, S.A. 1993. River response to base level change: implications for sequence stratigraphy. *The Journal of Geology* 101, 279-294.

Scott, B. 2006. The Early Middle Palaeolithic of Britain; origins, technology and landscape. Unpublished Ph.D. thesis, University of Durham.

Scott, B. 2010. The investigation of Baker's Hole, Northfleet, Kent, 1909-1914; the impact of collection history upon the interpretation of archaeological data. *Proceedings of the Geologists' Association* 121, 77-82.

Scott, B. 2011. *Becoming Neanderthals: the earlier British Middle Palaeolithic.* Oxford; Oxbow Books.

Scott, B. & Ashton, N. 2011. The early Middle Palaeolithic: the European context. In: N. Ashton, S.G. Lewis & C. Stringer (eds.). *The ancient human occupation of Britain*. Amsterdam; London: Elsevier, 91-112.Developments in Quaternary Science 14.

Scott, B., Ashton, N., Lewis, S.G., Parfitt, S. & White, M. 2011. Technology and landscape use in the Early Middle Palaeolithic of the Thames Valley. In: N. Ashton, S.G. Lewis & C. Stringer (eds.). *The ancient human occupation of Britain*. Amsterdam; London: Elsevier, 67-89. Developments in Quaternary Science 14.

Scott, B., Ashton, N., Penkman, K.E.H., Preece, C. & White, M. 2010. The position and context of Middle Palaeolithic industries from the Ebbsfleet Valley, Kent, UK. *Journal of Quaternary Science* 25(6), 931-944.

Scott, B., Bates, M., Bates, R., Conneller, C., Pope, M., Shaw, A. & Smith, G. 2014. A new view from La Cotte de St Brelade, Jersey. *Antiquity* 88, 13-29.

Scott, B. & Shaw, A. 2009. The quiet man of Kent: the contribution of F.C.J. Spurrell to the early years of Palaeolithic archaeology. In: R.T. Hosfield, F.F. Wenban-Smith & M.I. Pope (eds.). Great prehistorians: 150 years of Palaeolithic research, 1859-2009. *Lithics* 30, 53-65.

Scott, B. & Shaw, A. 2018. La Cotte de St Brelade. Placemnaking, assemblage and persistence in the Normano-Breton Gulf. In: M. Pope, J.

McNabb & C. Gamble (eds.). *Crossing the human threshold. Dynamic transformation and persistent places during the Middle Pleistocene.* London; New York: Routledge,123-141.

Scott-Jackson, J.E.1992. Lower Palaeolithic finds at Wood Hill, East Kent: a geological and geomorphological approach to an archaeological problem. *Lithics* 13, 11-16.

Scott-Jackson, J.E. 2000. *Lower and Middle Palaeolithic artefacts from deposits mapped as Clay-with-flints: A new synthesis with significant implications for the earliest occupation of Britain*. Oxford; Oxbow.Books.

Scott-Jackson, J.E. 2000a. *Lower and Middle Palaeolithic artefacts from deposits mapped as Clay-with-flints: A new synthesis with significant implications for the earliest occupation of Britain* by N. Ashton. Reviewed in *Lithics* 22, 66-68.

Scott-Jackson, J.E. 2000b. *Lower and Middle Palaeolithic artefacts from deposits mapped as Clay-with-flints: A new synthesis with significant implications for the earliest occupation of Britain* by F.F. Wenban-Smith. Reviewed in *Antiquity* 75(290),693-694.

Scott-Jackson, J.E. & Scott-Jackson, W.B. 2008. *Alternative location modelling of a Lower-Middle Palaeolithic site on deposits mapped as Clay-with-flints in southern England, UK.* PADMAC Unit Working Paper. Retrieved on 20 June 2017 from World Wide Web: https://www.academia.edu/6509923/

Scott-Jackson, J.E. & Scott-Jackson, W.B. 2010. *Geoarchaeological investigations at Arrewig Lane, near Chesham, Buckinghamshire*. PADMAC Unit Working Paper. Retrieved on 15 June 2017 from World Wide Web. users.ox.ac.uk/~padmac/assests/PADMAC Working Paper Arrewig Lane.

Scott-Jackson, J.E. & Winton, V. 2001. Recent investigations at Dickett's Field, Yarnhams Farm, Holybourne, Hants. In: S. Milliken & J. Cook (eds.), *A very remote period indeed: papers on the Palaeolithic presented to Derek Roe*. Oxford: Oxbow, 214-222.

Shackley, M 1981. On the Palaeolithic archaeology of Hampshire. In: S.J. Shennan & R.T. Schadla-Hall (eds.). *The archaeology of Hampshire. From the Palaeolithic to the Industrial Revolution.* Winchester: Hampshire Field Club and Archaeological Society, 4-9.

Shackleton, N.J. 1987. Oxygen isotopes, ice volume and sea level. *Quaternary Science Reviews* 6, 183-190.

Shaw, A., Bates, M., Conneller, C., Gamble, C., Julien, A-M., McNabb, J., Pope, M. & Scott, B. 2016. The archaeology of persistent places: the Palaeolithic case of La Cotte de St Brelade, Jersey. *Antiquity* 90 (354), 1437-1453.

Shaw, A. & Scott, B. 2016. Site and artefact studies. In: M. White (ed.). *Lost landscapes of Palaeolithic Britain*. Oxford: Oxbow Books,103-129.. Oxbow Archaeology Monograph 26.

Shennan, I., Peltier, W.R., Drummond, R. & Horton, B. 2002. Global to local scale parameters determining relative sea-level changes and the post-glacial isostatic adjustment of Great Britain. *Quaternary Science Reviews* 21(1-3), 397-408.

Sherlock, R.L. & Pocock, R.W. 1924. *The geology of the country around Hertford*. London: HMSO. Memoirs of the Geological Survey England and Wales. Explanation of Sheet 239.

Shrubsole, O.A. 1895. On flint implements of a primitive type from old (pre-glacial) hill-gravels in Berkshire. *The Journal of the Anthropological Institute of Great Britain and Ireland* 24, 44-49.

Slimak, L. & Giraud, Y. 2007. Circulations sur plusieurs centaines de kilomètres durant le Paleolithique moyen. Contribution à la connaissances des sociétiés néandertaliennes. *Compte Rendus Palevol* 6(5), 359-369.

Small, R.J. 1961. The morphology of Chalk escarpments: a critical discussion. *Transactions and papers of the Institute of British Geographers* 29, 71-90.

Small, R.J. 1965. The role of spring sapping in the formation of Chalk escarpment valleys. Southampton: *Southampton Research Series in Geography 1,* 3-29.

Small, R.J. & Fischer, G.C. 1970. The origin of the secondary escarpment of the South Downs. *Transactions of the Institute of British Geographers* 49, 97-107.

Smith, A.J. 1985. A catastrophic origin for the palaeovalley system of the eastern English Channel. *Marine Geology* 64, 65-75.

Smith, D.I. & Atkinson, C. 1976. Process, landforms and climate in limestone regions. In: E.D. Derbyshire (ed.). *Geomorphology and climate*. London: Wiley, 367-409.

Smith, G.E. 1931. The evolution of man. In: G.E. Smith, A. Keith, F.G. Parsons, M.C. Burkitt, H.J.E. Peake & J.L. Myres (eds.). *Early man: his origin, development and culture.* London: Ernest Benn, 13-46.

Smith, R.A. 1911. A Palaeolithic industry at Northfleet, Kent. *Archaeologia* 62(2), 515-532.

Smith, R.A. 1915a. High-level finds in the Upper Thames Valley. *Proceedings of the Prehistoric Society of East Anglia* 2(1), 99-107.

Smith, R.A. 1915b. Prehistoric problems in geology. *Proceedings of the Geologists' Association* 26(1), 1-20.

Smith, R.A. 1919. Flint implements from the Palaeolithic 'floor' at Whipsnade, Beds. *Proceedings of the Society of Antiquaries* 2nd series XXXI, 39-50.

Smith, R.A. & Dewey, H. 1913. Stratification at Swanscombe: report on excavations made on behalf of the British Museum and H.M. Geological Survey. *Archaeologia* 64, 177-204.

Smith, W.G. 1894. *Man the primeval savage: his haunts and relics from the hill-tops of Bedfordshire to Blackwall*. London: Edward Stanford.

Smith, W.G. 1906. Human skeleton of Palaeolithic age. *Man* 6, 10-11.

Smith, W.G. 1907. Nature-made “eolithic implements”. *Man* 1907, 99-100.

Smith, W.G. 1908. “Eoliths”. *Man* 8, 49-53.

Smith, W.G. 1909. Dewlish “eoliths” and Elephas Meridioinalis. *Man* 9, 113-114.

Smith, W.G. 1916. Notes on the Palaeolithic floor near Caddington. *Archaeologia* 67, 49-74.

Sommé, J. 1988. Géomorphologie et stratigraphie. In: A. Tuffreau & J. Sommé (eds.). *Le gisement Paléolithique Moyen de Biache-Saint-Vaast (Pas-de-Calais) Volume 1. Stratigraphie, environnement, etudes archeologique (1ère partie).* Paris: Société Préhistorique Française, 27-45. Mémoires de la Société Préhistorique Française 21.

Sommer, M. 2004. Eoliths as evidence for human origins? *History and Philosophy of the Life Sciences* 26 (2), 209-241.

Sparks, B.W. 1949.The denudation chronology of the dip-slope of the South Downs. *Proceedings of the Geologists’ Association* 60(3), 165-215.

Sparks, B.W. & Lewis, W.V. 1957. Escarpment dry valleys near Pegsdon, Hertfordshire. *Proceedings of the Geologists’ Association* 68(1), 26-38.

Sperling, C.H.B., Goudie, A.S., Stoddart, D.R. & Poole, G.G. 1977. Dolines of the Dorset Chalklands and other areas in southern Britain. *Transactions of the Institute of British Geographers* 2(2), 205-223.

Spurrell, F.C.J. 1880a. On implements and chips from the floor of a Palaeolithic workshop. *The Archaeological Journal* 37, 294-299.

Spurrell, F.C.J. 1880b. On the discovery of the place where Palaeolithic implements were made at Crayford. *Quarterly Journal of the Geological Society of London* 36, 544-548.

Spurrell, F.C.J. 1883. Palaeolithic implements found in west Kent. *Archaeologia Cantiana* 15, 89-103.

Spurrell, F.C.J. 1884. On some Palaeolithic knapping tools and modes of using them. *The Journal of the Anthropological Institute of Great Britain and Ireland* 3, 109-114 & 117-118.

Spurrell, F.C.J. 1898. Excursion to Erith and Crayford. *Proceedings of the Geologists’ Association* 15, 110-113.

Stanier, P. 2000. *Stone quarry landscapes. The archaeology of quarrying in England.* Stroud:Tempus.

Starling, R. 2013. Preface. In: F. Wenban-Smith (ed.). *The Ebbsfleet elephant. Excavations at Southfleet Road, Swanscombe in advance of High*

Speed 1, 2003-4, Oxford: Oxford Archaeology, xxxi. Oxford Archaeology Monograph 20.

Stemerdink, C., Maddy, D., Bridgland, D.R. & Veldkamp, A. 2010. The construction of palaeodischarge time series for use in a study of fluvial system development of the Middle to Late Pleistocene Upper Thames. *Journal of Quaternary Science* 25(4), 447-460.

Stopes, H. 1899. On the discovery of Neritina Fluviatilis with a Pleistocene fauna and worked flints in the high terrace gravels of the Thames valley. *Journal of the Anthropological Institute of Great Britain and Ireland* 29 (3-4), 302-303.

Stopes, H.1900a. On the discovery of *Neritina fluviatalis* with a Pleistocene fauna and worked flints in High Terrace gravels of the Thames valley. *Journal of the Royal Anthropological Insititute* 29 (New Series 2), 302-303.

Stopes, H. 1900b. Pleistocene man in the Thames gravels. *The Athenaeum* 3795, 92-93.

Stringer, C. & Gamble, C. 1993. *In search of the Neanderthals*. London: Thames & Hudson.

Stuart, A.J. 1976. The history of the mammal fauna during the Ipswichian/last interglacial in England. *Philosophical Transactions of the Royal Society of London Series B* 276(945), 221-50.

Sutcliffe, A.J.1995. Insularity of the British Isles 250,000-20,000 years ago: the mammalian. Including human, evidence. In: R.C. Preece (ed.) *Island Britain: a Quaternary perspective*. London: The Geological Society, 127-140.Geological Society Special Publication 96.

Svenning, J-C. 2002. A review of natural vegetation openness in north-western Europe. *Biological Conservation* 104, 133-148.

Talon, M. L'apport de la géomorphologie au diagnostic archéologique sur le project du Canal Seine-Nord Europe. *Géologues* 173, 28-32.

Taylor, B. 1985. One hundred years of the Hampshire Field Club. *Proceedings of the Hampshire Field Club and Archaeological Society* 41, 5-20.

Thomas, K.D. 1989. Vegetation of the British Chalklands in the Flandrian period: a response to Bush. *Journal of Archaeological Science* 16, 549-553.

Thompson, W.G. & Goldstein, S.L. 2006. A radiometric calibration of the SPECMAP timescale. *Quaternary Science Reviews* 25, 3207-3215.

Thurrell, R.G., Worssam, B.C. & Edmonds, E.A. 1968. *Geology of the country around Haslemere*. London: HMSO.

Tilley, C. 2008. Phenomenological approaches to landscape archaeology. In: D. Bruno & J. Thomas (eds.). *Handbook of landscape archaeology.* Walnut Creek, California: Left Coast Press, 271-276.

Todd, A.E. 1934. Early flake implements from “Clay-with-flints” on the Eastbourne Downs. *Proceedings of the Prehistoric Society of East Anglia* 7(3), 419-420.

Todd, A.E. 1936. Early palaeoliths from the summit of the South Downs. *Proceedings of the Prehistoric Society* 2(1-2), 140-143.

Toghill, P. 2000. *The geology of Britain: an introduction*. Marlborough: Airlife Publishing.

Toucanne, S., Zaragosi, S., Bourillet, J.F., Cremer, M., Eynaud, F., Van Vliet-Lanoë, B., Penaud, A., Fontanier, C., Turon, J.L., Cortijo, E. & Gibbard, P.L. 2009. Timing of massive ‘Fleuve Manche’ discharges over the last 350 kyr: insights into the European ice-sheet oscillations and the European drainage network from MISS 10 to 2. *Quaternary Science Reviews* 28, 1238-1256.

Toucanne, S., Zaragosi, S., Bourillet, J-F., Marieu, V., Cremer, M., Kageyama, M., Van Vliet-Lanoë, B., Eynaud, F., Turon, J-L. & Gibbard, P.L. 2010.The first estimation of Fleuve Manche palaeoriver discharge during the last deglaciation: evidence for Fennoscandian ice sheet meltwater flow in the English Channel *ca*. 20-18 ka ago. *Earth and Planetary Science Letters* 290, 459-473.

Treacher, L. 1896a. Palaeolithic man in east Berks. 1 - Cookham and Maidenhead. *Berkshire, Buckinghamshire and Oxfordshire Archaeological Journal* 2, 16-18.

Treacher, L. 1896b. Palaeolithic man in east Berks. 2 – Ruscombe and Twyford. *Berkshire, Buckinghamshire and Oxfordshire Archaeological Journal* 2, 39-43.

Treacher, L. 1897.Excursion to Cookham. *Proceedings of the Geologists’ Association* 15, 101-104.

Treacher, L. 1904. On the occurrence of stone implements in the Thames Valley between Reading and Maidenhead. *Man* (4), 17-19.

Treacher, L. 1905. Some notes on the Parish of Ruscombe, Berks. *Berkshire, Buckinghamshire and Oxfordshire Archaeological Journal* 11, 43-6.

Treacher, L. 1909. Excursion to Limpsfield and Westerham. *Proceedings of the Geologists’ Association* 21(1), 59-64.

Treacher, L. 1926. Excursion to Shiplake. *Proceedings of the Geologists’ Association* 37(4), 440-441.

Treacher, M.S., Arkell, W.J. & Oakley, K.P. 1948. On the ancient channel between Caversham and Henley, Oxfordshire, and its contained flint implements. *Proceedings of the Prehistoric Society* 14, 126-154.

Trigger, B.G. 2006. *A history of archaeological thought*. (2nd edition). Cambridge: Cambridge University Press.

Trow, S. 2016. 25 years of development-led archaeology in England: strengths, weaknesses, opportunities and threats. In: P. Novaković, M. Horňák, M.P. Guermandi, H. Stäuble, P. Depaepe & J-P Demoule (eds.). *Recent developments in preventive archaeology in Europe. Proceedings of the 22nd EEA meeting in Vilnius 2016*. Ljubljana: Ljubljana University Faculty of Arts, 55-69.

Tuffreau, A. 2001. Historique de recherches sur le complexe des moyennes terrasses du basin de la Somme et sur ses industries. In: A. Tuffreau (ed.). *L'Acheuléen dans la vallée de la Somme et Paléolithique moyen dans le nord de la France: données recentes.* Lille: Centre d'Études et de Recherches Préhistoriques, 9-18.

Tuffreau, A. 2009. Victor Commont. In: R.T. Hosfield, F.F. Wenban-Smith & M.I. Pope (eds.). Great prehistorians: 150 years of Palaeolithic research, 1859-2009. *Lithics* 30, 117-125.

Tuffreau, A. & Antoine, P. 1995. The earliest occupation of Europe: northwestern Europe. In: W. Roebroeks & T. van Kolfcholen (eds.). *The earliest occupation of Europe. Proceedings of the European Science Foundation Workshop at Tauteval (France), 1993.* Leiden: University of Leiden, 148-163.

Tuffreau, A., Lamotte, A. & Goval, E. 2008. Les industries acheuléennes de la France septentrionale. *L'Anthropologie* 112, 104-139.

Tuffreau, A., Lamotte, A. & Marcy, J-L. 1997. Land-use and site function in Acheulean complexes of the Somme. *World Archaeology* 29(2), 225-241.

Turq, A., Faivre, J-P., Gravina, B. & Bourguignon, L. 2017. Building models of Neanderthal territories from raw material transports in the Aquitaine Basin (southwestern France). *Quaternary International* 433, 88-101.

Tyldesley, J.A. 1986. *The Wolvercote Channel handaxe assemblage: a comparative study*. Oxford: Archaeopress. British Archaeological Reports British series 153.

Vallin, L. & Masson, B. 2004. Behaviour towards lithic production during the Middle Palaeolithic: examples from Hermies le Champ Bruquette and Hermies le Tio Marché. In: E.A.Walker, F.F. Wenban-Smith & F. Healy (eds.). *Lithics in action: papers from the conference 'Lithic studies in the year 2000'.* Oxford: Oxbow Books, 6-25. Lithic Studies Society Occasional Paper 8.

Vandenberghe, J. 1995. Tiimescales, climate and river development. *Quaternary Science Reviews* 14, 631-638.

Vandenberghe, J. 2003. Climate forcing of fluvial system development: an evolution of ideas. *Quaternary Science Reviews* 22, 2053-2060.

Vandenberghe, J. 2010. Extrinsic and intrinsic forcing of fluvial development: understanding natural and anthropogenic influences. *Proceedings of the Geologists' Association* 121, 107-112.

Vasskog, K., Langebroek, P.M., Andrews, J.T., Nilsen, J.E.Ø. & Nesje, A. 2015. The Greenland ice sheet during the last glacial cycle: current ice loss

and contribution ot sea-level rise from a palaeoclimatic perspective. *Earth-Science Reviews* 150, 45-67.

Veldkamp, A. & van den Berg, M.W. 1993. Three-dimensional modelling of Quaternary fluvial dynamics in a climo-tectonic dependent system. A case study of the Maas record (Maastricht, The Netherlands). *Global and Planetary Change* 8, 203-218.

Vera, F.M.W. 2000. *Grazing ecology and forest history* by R. Bradshaw. Reviewed in *Forest Ecology and Management* 165, 327-329.

Vera, F.M.W. 2002. The dynamic European forest. *Arboricultural Journal* 26, 179-211.

Vignard, E. 1957. Les gisements Levalloiso-Moustériens de la tranchée du nouveau canal du Nord a Catigny-Béhancourt-Sermaize près de Noyon (Oise). *Bulletin de la Société Préhistorique de France 54(10), 606-611*Wade, K. 2018. What might the future hold for archaeology? *Rescue News* 126, 5.

Wainwright, G. 1999. Preface. In: J. Wymer. *The Lower Palaeolithic occupation of Britain*. Salisbury: Trust for Wessex Archaeology, vi.

Walker, E.A. 2009. Discoveries in Devon: the works of Father John MacEnery and William Pengelly. In: R.T. Hosfield, F.F .Wenban-Smith & M.I. Pope (eds.). Great prehistorians:150 years of Palaeolithic research, 1859-2009. *Lithics* 30, 25-33.

Waller, M.P. & Hamilton, S.D. 1998. The vegetational history of the South Downs: Mount Caburn. In: J.B. Murton, C.A. Whiteman, M.R. Bates, D.R. Bridgland, A.J. Long, M.B. Roberts & M.P. Waller (eds.). *The Quaternary of Kent and Sussex*. *Field Guide*. London: Quaternary Research Association, 115-120.

Ward, S. L., Neill, S.P., Scourse, J.D., Bradley, S.L. & Uehara 2016. Sensitivity of palaeotidal models of the northwest European shelf seas to glacial isostatic adjustment since the Last Glacial Maximum. *Quaternary Science Reviews* 151, 198-211.

Warren, S.H. 1905. On the origin of “eolithic” flints by natural causes, especially by the foundering of drifts. *Journal of the Anthropological Institute of Great Britain and Ireland* 35 (2), 337-364.

Warren, S.H. 1914. The experimental investigation of flint fracture and its application to problems of human implements. *Journal of the Anthropological Institute of Great Britain and Ireland* 44(2), 412-450.

Wass, H. 2019. HS2: the largest archaeological investigation ever undertaken in the UK. *British Archaeology* 166, 32-41.

Watt, A.S. 1947. Pattern and process in the plant community. *Journal of Ecology* 35(1/2), 1-22.

Watt, K.A. 1990. *Nineteeth century brickmaking innovations in Britain: building and technological change.* Unpublished Ph.D. thesis. University of York.

Wenban-Smith, F.F 2004a. *Stopes Palaeolithic Project: Final Report.* English Heritage/Archaeological Data Service. Retrieved on 26 September 2018 from World Wide Web. http://archaeologydataservice.ac.uk/archives/view/stopes_eh_2007/ Search terms used: Stopes Palaeolithic Project.

Wenban-Smith, F.F. 2004b. Bringing behaviour into focus: archaic landscapes and lithic technology. In: E.A. Walker, F.F. Wenban-Smith and F. Healy((eds.). *Lithics in action: papers from the conference Lithic Studies in the year 2000.* Oxford: Oxbow Books, 48-56. Lithic Studies Society Occasional Paper 8.

Wenban-Smith, F.F. 2009. Henry Stopes (1852-1902): engineer, brewer and anthropologist. In: R.T. Hosfield, F.F. Wenban-Smith & M.I. Pope (eds.). Great prehistorians: 150 years of Palaeolithic research, 1859-2009. *Lithics* 30,

Wenban-Smith, F.F. (ed.) 2013. *The Ebbsfleet elephant. Excavations at Southfleet Road, Swanscombe in advance of High Speed 1, 2003-4*, Oxford: Oxford Archaeology. Oxford Archaeology Monograph 20.

Wenban-Smith, F.F., Allen, P., Bates, M.R., Parfitt, S.A., Preece, R.C., Stewart, J.R. Turner, C. & Whittaker, J.E. 2006. The Clactonian elephant butchery site at Southfleet Road, Ebbsfleet, UK.*Journal of Quaternary Science* 21(5), 471-483.

Wenban-Smith, F.F., Bates, M.R. & Schwenninger, J-L. 2010. Early Devensian (MIS 5d-5b) occupation at Dartford, southeast England. *Journal of Quaternary Science* 25(8), 1193-1199.

Wenban-Smith, F.F., Bates, M.R. & Marshall, G. 2007. *Medway Valley Palaeolithic Project final report: the Palaeolithic resource in the Medway Gravels (Kent).* Retrieved on 12 April 2019 from World Wide Web. https://archaeologydataservice.ac.uk/archives/view/medway_eh_2009/

Wenban-Smith, F.F., Gamble, C.& ApSimon, A. 2000. The Lower Palaeolithic site at Red Barns, Portchester, Hampshire: bifacial technology, raw material quality, and the organisation of Archaic behaviour. *Proceedings of the Prehistoric Society 66, 209-225.*

Wessex Archaeology 1990. *The Southern Rivers Palaeolithic Project. A survey of the Lower Palaeolithic Sites South of the Thames. The research design*. Salisbury: Wessex Archaeology.

Wessex Archaeology 1993a. *The Southern Rivers Palaeolithic Project report 2, region 4 (south of the Thames) and region 1 (southwest England).* Salisbury: Trust for Wessex Archaeology.

Wessex Archaeology 1993b. *The Southern Rivers Palaeolithic Project report 2, region 6 (Sussex rivers).* Salisbury: Trust for Wessex Archaeology.

Wessex Archaeology 1996. *The English Rivers Palaeolithic Project Report 5, region 7 (Thames) and region 10 (Warwickshire Avon).* Salisbury: Trust for Wessex Archaeology.

Westaway, R. 2001. Flow in the lower continental crust as a mechanism for the Quaternary uplift of the Rhenish Massif, north-west Europe. In: D. Maddy, M.G. Macklin & J.C. Woodward (eds.). *River basin sediment systems: archives of environmental change*. Abingdon: A.A. Balkema, 87-167.

Westaway, R. 2010. Cenozoic uplift of southwest England. *Journal of Quaternary Science* 25(4), 419-432.

Westaway, R. & Bridgland, D.R. 2010. Causes, consequences and chronology of large-magnitude palaeoflows in Middle and Late Pleistocene river systems of northwest Europe. *Earth Surface Processes and Landforms* 35, 1071-1094.

Westaway, R., Bridgland, D. & White, M. 2006. The Quaternary uplift history of central southern England: evidence from the terraces of the Solent River system and nearby raised beaches. *Quaternary Science Reviews* 25, 2212-2250.

Westaway, R., Maddy, D. & Bridgland, D. 2002. Flow in the lower continental crust as a mechanism for the Quaternary uplift of south-east England: constraints from the Thames terrace record. *Quaternary Science Reviews* 21, 559-603.

Wheatley, D. & Gillings, M. 2000. Vision, perception and GIS: developing enriched approaches to the study of archaeological visibility. In: G. Lock (ed.). *Beyond the map: archaeology and spatial technologies.* Oxford: IOS Press, 1-27.

White, H.J.O. 1943. Llewellyn Treacher. *Quarterly Journal of the Geological Society* 99, 90.

White, H.P. 1982. *A regional history of the railways of Great Britain volume 2. Southern England*. (4th edition). Newton Abbott: David and Charles.

White, H.J. 1987. *A regional history of the railways of Great Britain volume 3. Greater London.* 3rd. rev. ed. Newton Abbot: David & Charles.

White, M.J. 1997. The earlier Palaeolithic occupation of the Chilterns (southern England): reassessing the sites of Worthington G. Smith. *Antiquity* 71, 912-31.

White, M. J. 2015. 'Dancing to the rhythms of the biotidal zone': settlement history and culture history in Middle Pleistocene Britain. In: F. Coward, R. Hosfield, M. Pope & F. Wenban-Smith (eds.). *Settlement, society and cognition in human evolution*. Cambridge: Cambridge University Press, 154-173.

White, M.J. 2016a. Palaeolithic archaeology, commercial quarrying and the Aggregates Levy Sustainability Fund. In: M.J. White (ed.) 2016. *Lost landscapes of Palaeolithic Britain: the contribution of projects funded by the Aggregates Levy Sustainability Fund 2002-2011*. Oxford:Oxford Archaeology,1-9. Oxford Archaeology Monograph 26.

White, M.J. 2016b. Lost landscapes of the British Palaeolithic: where do we go from here? In: M.J. White (ed.) 2016. *Lost landscapes of Palaeolithic*

Britain: the contribution of projects funded by the Aggregates Levy Sustainability Fund 2002-2011. Oxford: Oxford Archaeology,131-136. Oxford Archaeology Monograph 26.

White, M.J. 2017. *William Boyd Dawkins and the Victorian science of cave hunting. Three men in a cavern.* Barnsley: Pen and Sword Books.

White, M.J. & Bridgland, D. 2018. Thresholds in lithic technology and human behaviour during MIS9 in Britain. In: M. Pope, J. McNabb & C. Gamble (eds.). *Crossing the human threshold. Dynamic transformation and persistent places during the Middle Pleistocene.* London; New York: Routledge,165-191.

White, M.J., Bridgland, D.R., Schreve, D.C., White, T.S. & Penkman, K.E.H. 2018. Well-dated fluvial sequences as templates for patterns of handaxe distribution: understanding the record of Acheulean acivity in the Thames and its correlatives. *Quaternary International* 480, 118-131.

White, M.J., Lewis, S.G. & McNabb, J. 1999. Excavations at the Lower Palaeolithic site of Whipsnade, Bedfordshire, 1992-4. *Proceedings of the Geologists' Association* 110, 241-255.

White, M.J. & Pettitt, P.B. 2011. The British Late Middle Palaeolithic: an interpretative synthesis of Neanderthal occupation at the northwest edge of the Pleistocene world. *Journal of World Prehistory* (2011), 25-97.

White, M., Pettitt, P. & Schreve, D. 2016. Shoot first, ask questions later: interpretative narratives of Neanderthal hunting. *Quaternary Science Reviews* 140, 1-20.

White, M.J. & Schreve, D.C. 2000. Island Britain – peninsula Britain: palaeogeography, colonisation and the Lower Palaeolithic settlement of the British Isles. *Proceedings of the Prehistoric Society* 66, 1-28.

White, M.J., Scott, B. & Ashton, N.M. 2006. The early Middle Palaeolithic in Britain: archaeology, settlement history and human behaviour. *Journal of Quaternary Science* 21, 525-541.

Whitehouse, N.J. & Smith, D.N. 2004. 'Islands' in Holocene forests: implications for forest openness, landscape clearance and 'culture-steppe' species. *Environmental Archaeology* 9(2), 199-208.

Wilkinson, K. 2001. Prospecting the Palaeolithic: strategies for the archaeological investigation of Middle Pleistocene deposits in southern England. In: F.F. Wenban-Smith & R.T. Hosfield (eds.). *Palaeolithic archaeology of the Solent River. Proceedings of the Lithic Studies Society day meeting held at the Department of Archaeology, University of Southampton on 15 January 2000.* London: Lithic Studies Society, 99-109.

Wilkinson, K.N. 2003. Colluvial deposits in dry valleys of southern England as proxy indicators of palaeoenvironmental and land-use change. *Geoarchaeology* 18 (7), 725-755.

Wilkinson, K. 2007. The Lower and Middle Palaeolithic of Hampshire. Solent Thames Archaeological Research Framework. Oxford: Oxford Archaeology. Retrieved on 15 October 2018 from World Wide Web.

https://oxfordarchaeology.com/images/pdfs/Solent_Thames/County_resource_assessments/Lower_Middle_Palaeo_Hants.pdf

Williams, P.W. 2004. Doline. In A.S. Goudie (ed.). *Encyclopaedia of Geomorphology*. London: Routledge, 266-270.

Williams, R.B.G.1965. Permafrost in England during the Last Glacial Period. *Nature* 205, 1304-1305.

Williams, R.B.G. 1968. Some estimates of periglacial erosion in southern and eastern England. *Biuletyn Peryglacjalny* 17, 311-335.

Williams, R.B.G. 1980. Weathering and erosion of Chalk under periglacial conditions. In: D.K.C. Jones (ed.). *The shaping of southern England.* London: Academic Press, 225-248. Institute of British Geographers special publication 11.

Williams, R.B.G. 1986. Periglacial phenomena in the South Downs. In: G. de G. Sieveking & M.B. Hart (eds.). *The scientific study of flint and chert. Proceedings of the fourth international flint symposium held at Brighton Polytechninc 1-15 April 1983*. Cambridge: Cambridge University Press, 161-167.

Williams, R.B.G & Robinson, D.A. 1983. The landforms of Sussex. In: The Geography Editorial Committee, University of Sussex (eds.). *Sussex: environment, landscape and society.* Gloucester: Alan Sutton, 33-49.

Winton, V. 2004. *A study of Palaeolithic artefacts from selected sites on deposits mapped as Clay-with-flints of southern England with particular reference to handaxe manufacture*. Oxford: Archaeopress. British Archaeological Reports British Series 360.

Woodcock, A. 1981. *The Lower and Middle Palaeolithic periods in Sussex.* Oxford: Archeopress. British Archaeological Reports British Series 94.

Woodcock, A. 1986. The Lower and Middle Palaeolithic in Sussex: a summary of current knowledge, present research and future objectives. In: S.N. Collcutt (ed.). *The Palaeolithic of Britain and its nearest neighbours: recent trends.* Sheffield: University of Sheffield Department of Archaeology and Prehistory, 31-35.

Wooldridge,S.W. & Linton, D.L. *Structure, surface and drainiage in south-east England*. London: George Philip & Son.

Worsley, P. 2016. On the nature and significane of two mega Chalk dissolution pipe infills, Goring Gap, Chiltern Hills, south Oxfordshire, UK. *Proceedings of the Geologists' Association* 127, 370-376.

Wragg Sykes, R.M. 2015. To see a world in a hafted tool: birch pitch composite technology, cognition and memory in Neanderthals. In: F. Coward, R. Hosfield, M. Pope & F. Wenban-Smith (eds.). *Settlement, society and cognition in human evolution*. Cambridge: Cambridge University Press, 117-137.

Wu, Q., Deng, C. & Chen, Z. 2016. Automated delineation of karst sinkholes from LIDAR-derived digital evaluation models. *Geomorphology* 266, 1-10.

Wymer, J. 1968. *Lower Palaeolithic archaeology in Britain as represented by the Thames Valley.* London: John Baker.

Wymer, J. 1980. The excavation of the Acheulean site at Gaddesden Row. *Bedfordshire Archaeological Journal* 14, 2-4.

Wymer, J. 1994. Comments. *Cambridge Archaeological Journal* 4(1), 2-4.

Wymer, J. 1996. The English Rivers Palaeolithic Survey. In: C. Gamble & A.J. Lawson (eds.). *The English Palaeolithic reviewed: papers from a day conference held at the Society of Antiquaries of London, 28 October 1994.* Salisbury: Trust for Wessex Archaeology, 7-22.

Wymer, J. 1999. *The Lower Palaeolithic occupation of Britain.* Salisbury: Trust for Wessex Archaeology.

Young, B. & Lake, R.D. 1988. *The geology of the country around Brighton and Worthing*. London:HMSO.

Zedeño, M.N. 2008. The archaeology of territory and territoriality. In: D. Bruno & J. Thomas (eds.). *Handbook of landscape archaeology.* Walnut Creek, California: Left Coast Press,210-217.

Zumpano, V., Pisano, L. & Parise, M. 2019. An integrated framework to identify and analyse karst sinkholes. *Geomorphology* 332, 213-225.